

"Now, each cubic foot of water converted into steam exists in the cylinder before expansion begins under a pressure p , it therefore occupies a relative space by Equation (c), represented by

$$u = \frac{1}{a + \beta p}$$

"Now, the number of cubic feet of water which is evaporated in the boiler, and passes into the cylinder at every stroke of the engine in the form of steam, is represented by $\frac{E}{N}$; therefore the space occupied in cubic feet in the cylinder when the valve is closed and expansion begins will be represented by $\frac{E}{N} \left(\frac{1}{a + \beta p} \right)$."

There is an insuperable objection to any measure of the duty of the engine, as estimated by the quantity of water diminished in the boiler in a given time; and that is, that all the water removed is not evaporated. In fact, a large portion of water, called "priming" by engineers, is conveyed from the boiler into the cylinders in a state of fine particles, possessed of no elastic force whatever. The proportion which this bears to the amount evaporated seems to depend on the violence of the ebullition and the form of the throttle pipe. Substances which have a tendency to modify the action of the boiling water, such as butter or potato parings, likewise affect the quantity of priming; and in tubular boilers the priming is found to be greatest when the extent of fire-surface is greatest. All these disturbing causes, which it is impossible to contemplate in theory, render uncertain any formulae for the work done by the engine as deduced from the decrease of water in the boiler. In p. 65, on the crank, the proof given by Woolhouse, that the power multiplied by the space which it passes over is equal to the weight or resistance multiplied by the space which it passes over, evidently assumes that the mass of the connecting rod may be neglected, otherwise the proof would be incorrect. Mr. Woolhouse, as quoted by Mr. Hann, assumes that the pressure against the crank is the resolved part of the pressure applied at the lower end of the connecting rod. The following is a more accurate investigation:—

Let the length of the connecting rod = r ; the radius of the crank = ρ ; and θ and ϕ the angles they make respectively with a vertical through the centre of the crank at time t . Let this vertical be taken for the axis of x . Let x, y be the coordinates of the centre of gravity of rod at time t ; the origin, that point in the vertical which coincides with the lower end of the rod when $\theta = \phi = 0$; X, Y , reactions between rod and radius of crank parallel to the axes of x and y ; m = mass of rod; and X', Y' , the pressures at lower end of rod parallel x, y : then,

$$x = \rho(1 - \cos \phi) + \frac{r}{2} \cos \theta, \quad y = \frac{r}{2} \sin \theta;$$

also, $r \sin \theta = \rho \sin \phi$. These are the geometrical relations

For the mechanical we have—

$$\begin{cases} m \frac{d^2 x}{dt^2} = -mg + X' - X \\ m \frac{d^2 y}{dt^2} = Y' - Y \end{cases}$$

$$\frac{mr^2}{12} \cdot \frac{d^2 \theta}{dt^2} = (X + X') \frac{r}{2} \sin \theta - (Y + Y') \frac{r}{2} \cos \theta;$$

$$x = \rho(1 - \cos \phi) + \frac{r}{2} \cos \theta = \rho \left\{ 1 - \sqrt{1 - \frac{r^2}{\rho^2} \sin^2 \theta} \right\} + \frac{r}{2} \cos \theta.$$

From these equations, X', Y' , and Y can be obtained in terms of $X, \theta, \frac{d\theta}{dt}$, and $\frac{d^2 \theta}{dt^2}$; also, since $\sin \theta = \frac{\rho}{r} \sin \phi$, θ and its differential coefficients depend only on ϕ and its differential coefficients; therefore, if the angular velocity of the radius of the crank be given, $\frac{d\phi}{dt}$ is given, and ϕ is given; $\therefore \theta, \frac{d\theta}{dt}$ and $\frac{d^2 \theta}{dt^2}$ are given; and $\therefore X', Y'$, and Y are known. When, however, $m = 0$, $X = X', Y = Y', X \sin \theta + Y \cos \theta = 0$,—and Mr. Woolhouse's solution is correct.

We must here conclude our notice of Mr. Hann's treatise—Part I. We hope that before long, Part II. will make its appearance, and that the author will be enabled to continue, without interruption, his useful labours, which are alike honourable to himself and to the collegiate body of which he is so distinguished a member.

Practical Rules for Ascertaining the Relations between the Alterations in Gradients, and the Corresponding Changes in the Contents. By DENZIL J. H. IBBETSON, civil engineer. London: Weale. 8vo. pp. 24.

To the engineer and surveyor, the object of this little work will be sufficiently obvious from its title. The increase or diminution of earthwork on railways consequent on the alteration of gradients, is here calculated on the supposition that the altered gradient is parallel to the original gradient. It is important to observe that the calculations are based on this hypothesis exclusively, because they are applicable to no other. The case taken is a very unpractical one, and of so rare occurrence, and so simple, that it is a very insufficient excuse for rushing into print. Where gradients are altered at all, it is usually their inclination which is subjected to the alteration. Our author, at page 11, gives incidentally a hint for modifying his formulae to these more general cases; but the method is unsatisfactory and uncertain—instances might be suggested in which it would give results which were the exact reverse of the truth; that is, results which represented the earthwork to be increased, where it was in reality diminished by the alteration of the gradient; and conversely.

Mr. Ibbetson's formulae do not suppose the cross section to be known: they depend on the inclination of the slopes, but not on their comparative height on opposite sides of the railway. No distinction is made between a cutting through a hill and one round it; and no special rules are given for sidelong ground or open cutting. It is quite clear that such a rough method of proceeding could never be permitted in making the earthwork for *working* or *contract* estimates. In these, considerable accuracy is imperatively required, and can be ensured by no method but that of taking out the quantities from the cross section.

For parliamentary purposes less accuracy is wanted. In the preliminary investigations the distinction between equal cutting and sidelong ground, is considered unnecessary. Here then, perhaps, the proposed method might sometimes apply. But, unfortunately, the very cause (laxity of investigation) which would palliate the inaccuracies of the method, at the same time excludes its comparatively inconsiderable results. The results of Mr. Ibbetson's formulae then would generally be too minute for parliamentary purposes, and too inexact for the purposes of the contractor.

However, the methods appear to be in themselves neat and simple enough. The propositions are stated in that precise language which always argues well for the correctness of them. There seems every reason to suppose that if Mr. Ibbetson would write another book on the practical cases of alteration of gradients, and confine himself to objects of practical utility, the result would be successfully obtained. There are no diagrams or demonstrations in his treatise. Against this method of giving mere recipes in the cookery-book fashion we always protest. But he has taken up new ground, and one in which a qualified labourer is much wanted;—if he will permit the above suggestions to weigh with him, he may gain the credit of having effected a work, which though of great value and importance, has been hitherto unattempted.

A Proposed System for the more ready and correct Valuation of Carpenters' and Joiners' Works. By HENRY B. BROWNING. London: Weale.

Though this work of Mr. Browning's is founded on Peter Nicholson's system, yet he has carried it out in a new way, and instead of the labour employed, he proposes to calculate the quantities of materials used, and to give the elements of valuation in such minuteness, as to enable the builder to calculate them in detail. For this attempt, Mr. Browning deserves particular praise, for he has evidently taken conscientious pains in getting up his work, and bestowed great labour upon it; but we doubt whether the work will be extensively used by practical men, for whom the Builders' Price Books are found to contain more conveniently the information they want. The mode of calculating each part is carefully shown by Mr. Browning, and tables and forms are given with each example. In calculating the material for joiners' work, the several thicknesses are all reduced to a standard thickness of one inch, and then multiplied by the value of the inch deal. Thus, according to the price of inch deal, the price of materials will be determined. Mr. Browning does not, however, in the case of joiners' work, give the value of labour and nails, though, in the case of carpenters' work, he gives new tables, instead of the usual estimates.

While we award great praise to Mr. Browning, we must observe, that so far as experienced surveyors are concerned, the same minuteness of calculations is employed; but the reason why builders generally do not apply it, is, not from want of appreciation of its value,

or from want of capacity, but because such calculations require special proficiency, and they either use a price-book, or, if the case requires it, resort to a surveyor.

Copyright of Designs as Distinguished from Patentable Inventions.
By WM. SPENCE, Assoc. Inst. C.E., patent agent. London: V. and R. Stevens, 1847.

The object of this pamphlet is to show the exact degree of protection afforded by the registration of designs, and in particular to show that it does not supersede a patent. It carries out, therefore, the interpretations of the Registration Act, in the same view that we originally took on the passing of the act. We then showed that registration gave no protection for the principle of a design—only for the form. If, for example, a round cullender were registered, an oval cullender would be held to be no infringement. We may observe, by the bye, that the Registrar takes on himself to decide on what designs ought to be registered, whereas his jurisdiction is merely limited to the determination of the class in which the design is to be placed. If, however, a Registrar is to exercise any jurisdiction at all, it is desirable that an engineer should hold the appointment; so that at any rate the services of a competent authority may be secured.

DECIMAL WEIGHTS, MEASURES, AND MONEY.

One of the lesser public questions of the day, which is of special interest to our readers, is that concerning the tithing of money, weights, and measures; and which is the more worthy of notice, as it is making way on the road from theory to practice, as the new rupee, two-shilling piece, or tithe of a pound, will show.

The root of the whole matter is this, that our way of numbering, fixed by our mother tongue, is by tens, as one, two, &c., ten, eleven, twenty, twenty-one, thirty, forty, a hundred, a thousand, ten thousand, &c. We have also other usual ways, such as by twelves, as one dozen, one dozen-and-a-half, two dozen, and so forth; and by twenties, as a score, two score, three score and five, and so forth.

The way of numbering by tens is that followed in most tongues, and by all the higher races of mankind from the beginning of time; whereas some of the lower races can count only by twos or by threes, or as far as four at the utmost—all numbers beyond being out of their power to reckon.

The kind of notations now used, called Arabic, agrees well with the words, as 1, 10, 11, 20, 21, 30, 100, 1,000, 10,000.

All this is so very simple—it is so readily learned in our babyhood—it seems so trifling—that we are likely to be blamed for naming it; and yet what is the answer to what we are going to ask,—“Why do we not follow up the way in which we begin?”

One of the evils we now find in all our dealings and reckonings, is that we have all kinds of weights, measures, and money—only one of which in any way agrees with our way of numbering and reckoning. Some of our ways of measuring or weighing are by twos, some by threes, others by fours, eights, tens, twelves, sixteens, and twenties; in some cases even by fractions. If we buy by weight, we reckon by twenty, by one hundred and twelve, and by sixteen; we pay by twenty, by twelve, and by four; and we do the sum by ten—whereas if we bought by tens, paid by tens, and counted by tens, the operation would be easy, instead of being needlessly troublesome.

It is now some time since the state of our weights and measures awakened the notice of learned men. In the beginning of the last hundred years, a lawsuit showed that the Customs officers were using a wrong measure; while the Royal Society, having turned their attention to the measurement of the earth, found it needful to look into the standards of measurement used here. The Royal Society exchanged, in 1742, with the French Academy of Sciences, a set of standard measures and weights. These proceedings showed great differences between the standards kept at the Exchequer, Tower, Guildhall, Mint, Clockmakers' Company, Founders' Company, &c. In 1758 and 1759, a Parliamentary Committee was named to look into the standard. This Committee had a standard yard, and standard troy pound, made. In 1765, bills were brought in for establishing new standards, but fell to the ground. This Committee wished to use the pound troy instead of the pound avoirdupois.

In 1779, Lord Swinton tried, but fruitlessly, to get the English standards used in Scotland, as agreed in the Act of Union. He wrote a book upon this matter.

In 1798, Sir George Shuckburgh Evelyn made further enquiries into the state of the standards, which he published in the transactions of the Royal Society.

Before this, however, the Rev. Dr. George Skene Keith, who had laboured on the matter for more than thirty years, wrote a pamphlet in 1791, proposing a decimal system of weights, measures, and monies.

In 1795, the French, in their revolutionary madness for sweeping away every old law and custom, decimalized every kind of weight, measure, and money, on a plan which is called the metrical system, its first unit being a metre, the ten millionth part of a quadrant of the great circle. The French supposed they had laid their system on a natural and plain basis; but after investigations have left this a matter of doubt.

Our brethren in America had already adopted the dollar as their money unit, and divided it by tens into dimes and cents; but they have kept our weights and measures.

With the year 1800, a new agitation began for a change here. Professor Playfair and others wanted to have the French system, but happily they did not succeed. It was soon found that the French metrical system, having no fellowship with the old system of weights and measures, was not followed by the people, who could not be made to understand it; and the end was, that while the pure metrical system was kept for scientific purposes, it was for popular purposes provided with old names, and was called the “usual” system; thus a double metre was called a toise, a third of the metre was called a foot, a half kilogram a pound, an eighth of a hectolitre a bushel, and so forth. This was fully established in 1816.

In 1813, a Committee of the House of Commons was named, who published a report, and in 1818 a Royal Commission was named for weights and measures; under which, reports were published in 1819, 1820, and 1821. In 1824 and 1825 acts were passed, which named the standards, called “imperial standards,” which abolished all local weights and measures, and reduced the number of standards.

The greatest evil attendant upon the “imperial” measurement is, that the new gallon is made to contain ten pounds avoirdupois weight of distilled water, whereby the size in cubic inches is 277.274, giving a number most inconvenient for calculation.

In 1821, the American legislature took up the subject, and a most valuable report was drawn up by Mr. John Quincy Adams, afterwards President, who was in favour of the French metrical system. No important result has, however, been achieved in America.

Professor Robert Wallace, Mr. John Wilson, of Thornley, and others, proposed modifications of the English system, and published pamphlets upon it. In 1831 and 1832, General Pasley published a work suggesting a new standard and a decimal system, which he further carried in a second edition, published in 1834, and which for the labour bestowed upon it, is well worthy of being read. He proposed as a standard a fathom of the thousandth part of the nautical mile, which he adapted to the present systems of measurement, without causing much change in the value, though he introduces many new terms. His remarks upon the modes of measurement now in use are particularly valuable.

Mr. Babbage has been another labourer on this subject.

Since these, Professor De Morgan has repeatedly brought the decimal system before the notice of the public, and has written upon it. We have likewise made some remarks in a former volume of the Journal.

In the present session, the Chancellor of the Exchequer, having been questioned by Dr. Bowring, has agreed, as a first step, to coin a two-shilling piece.

However desirable it might be, in a theoretical point of view, to carry out forthwith any given system, experience has fully shown in France, that the only practicable way of getting an efficient and working system, is by conforming, so far as possible, with existing institutions and the habits of the people. The French “metrical” system has become the “usual” system, and as such works well, while most of theoretical advantages are already obtained. It is in conformity with this experience that any attempts must be made in England, and indeed this is pretty commonly allowed; although there are many differences of opinion as to details in carrying out a decimal system.

The great difference is as to the units and standards to be adopted. It has been assumed by some that a natural and invariable standard is to be looked for, which can always be referred to; and the measure of a degree of the meridian, the length of a pendulum, a quantity of distilled water, and various other such standards, have been proposed; but the attempt is perfectly futile, for there is no such natural standard. Captain Kater's imperial gallon is just as good a natural standard as the French metre, and it resolves itself into this—that all such units are arbitrary; and that therefore, instead of inventing a new arbitrary unit, it is better to adopt an old arbitrary unit.

Whatever weight may have been at one time given to the French metrical system, it can no longer be allowed, for it is found not to rest on a natural standard, while the French have failed in enforcing it.

There is no reason either why we should adopt the standards of an inferior people like the French, when our own, adopted in our vast empire, and by our brethren in the United States, of themselves secure a wider adoption.

The introduction of a decimal system must be in conformity with existing units, and it must be gradual. The first thing certainly seems to be a reform in the coinage—and this is determined upon, the pound being taken as the unit.

It need scarcely be said in these days, that a decimal system would diminish the work of children in learning arithmetic, giving them time for other pursuits; it would diminish the work of grown up people in reckoning; and it would enable all ranks to do what they cannot now—to reckon properly; the moral results of which may be expected, so far as prudence, economy, and foresight are concerned, to be much greater than any other.

The pound being taken as the unit, its tenth is the new two-shilling piece. The worth of this is about the same as the rupee, and it is to be hoped that the two will be made to agree, so that our East Indian currency may be uniform. The half-sovereign remains for a half-pound or five-tenths; the crown for a quarter-pound or twenty-five hundredths; the half-crown will, in all probability, be superseded; but while it remains, it causes no interference with a decimal coinage, having a defined value. The shilling is a half-rupee, the sixpence a quarter-rupee, but the fourpence is an anomalous coin, and it is to be hoped will be withdrawn from circulation, so as to leave room for a new groat or hundredth of a pound in silver, which will be the tenth of a rupee and fifth of a shilling. It has been well observed, that a very little change is involved in leaving the copper coinage, making the penny five thousandths, or four thousandths; the halfpenny two thousandths, and the farthing one thousandth.

The effect would be that the decimal monies would be a pound, a rupee, a groat, a farthing, leaving the others as conventional monies, as the crown, half-crown, and groat are now.

A change in the coinage is indispensable in reference to a change in the weights and measures. It is a matter of convenience now, particularly with women, to reckon by the unit, half, quarter, and half-quarter, the division by halves being one of the simplest arithmetical operations. In effecting any alterations, while a full decimal scale is given on a measure, the unit can be divided by halves, quarters, &c., on the other side, as is very common on rules and scales. This is a mere detail of the rule maker. With a change in the coinage the reason for a duodecimal division would drop, for a foot or a pound divided into tenths would readily answer to the parts of a rupee or a shilling.

In long measure the great dispute is, whether the unit of the foot shall be taken as the unit. If the foot be taken as the unit, it will cause little disturbance of the small measurements, but it will interfere with all the larger measurements. The mile must then be a mile of 5,000 present feet, instead of 5,280; the chain will become fractional, and so forth.

If the mile be taken as the unit, it will be divided into 1,000 fathoms, and 5,000 feet, or ten furlongs, one hundred chains, one thousand fathoms, ten thousand links, one hundred thousand half inches. The foot will be ten inches (to the present inch as 1.056 to .833), and one hundred hundredths. The square mile would be divided into one hundred square furlongs (of 6.4 acres each) 10,000 roods of square chains, and 1,000,000 square fathoms.

With regard to weight, the choice is also disturbed between the pound and the ton. The pound, however, appears preferable. The pound would be of ten ounces, one hundred drams, and one thousand grains; and the rising scale would be a cwt. of one hundred pounds, a last or load of one thousand lbs., and a ton of two thousand lbs. If a load of 1,000 lbs. were used forthwith in calculations, this would very much simplify matters.

As to liquid and dry measures, there are still greater discrepancies, but it appears desirable in all cases to employ the lb. or cubic foot, in preference to the gallon or bushel.

In conclusion, it may be observed, that it is particularly desirable that engineers and surveyors, who have so much to do with measurement and calculations, should at an early period direct their attention to this subject, particularly in reference to a choice of the units, as they will, thereby, very much advance the progress of legislative measures, and secure their conformity with the views of practical men.

THE GERMAN OVERLAND ROUTES TO INDIA.

The contest carried on, of old, between the seven cities for the honour of Homer's cradle, cannot be fiercer than that for the Indian route through middle Europe. As, however, that over the Luckmanjier pass (Lucus Major of the Romans) has attracted some notice, we shall briefly advert to it. It is now two years since Colonel Laricca, of the Piedmontese service, made the necessary studies and measurements, which were laid, in 1845, before the Company of Turin. He then proceeded to the northern slope of the Alps, while Inspector Carbonazzi surveyed the southern parts, and made levels and planimetric charts of the whole country, from the valley of the Tessino to the lake of Como.

In July and August last, these surveys were continued by the two engineers, and to which the services of Capt. Ricci, of the Piedmontese corps of Engineers, were added. All of them co-incided in the opinion, that the valley of the Crinallina was the fittest point to cross the Rhetian Alps. A superficial glance at the charts published in the Stuttgart *Eisenbahn-Zeitung* convinces one of the labour, at least, bestowed on that survey.

The plan of the route to be traversed, shows especially that the 34½ German leagues to be laid over with rails, presents no insurmountable difficulties, and has only to pass one *water-way*, while the Trieste line has to pass four. An extent of 23½ leagues of that line—viz., that from the Boden See to Sunhein (in the Rhine valley), conjointly with that from Progiasea to Locarno, is quite adapted for being passed by locomotive engines. A distance of 6½ leagues, however, between the above points, is very mountainous, and could not be passed but with gradients of 33.9 to 49.9 in every 1000. Here, therefore, stationary engines are to be used—unless, indeed, some means should be devised for using the water-power, so abundant in these Alpine localities, for that purpose. But even if that space should have to be gone over with the aid of animal power, or on an ordinary road, still the distance from the Langen to the Bodensu (239,435 metres), could be travelled over in 9 hours,—a great dispatch, indeed.

Another difficulty, not to be passed over, is a tunnel of 5,200 metres in length; but as it could be driven through the main rock, without embankments, the engineer thinks lightly of it. Pits, certainly, there could be none, except at the two ends of the shaft, as an enormous mass of rock overlays the projected tunnel.

The difficulty of passing this line in winter (here 8 months out of 12), is alleged to be obviated by covering the places likely to be overspread by avalanches or drift snow with galleries, as has been done on the Splügen, the St. Bernard, &c. While, in fine, this line will have to cope with difficulties of troublesome earth-works, and require every aid engineers can afford—the abundance of stone, timber, &c., may be considered as some compensation. If the Alps are and can be passed, this line seems to present the easiest access from Upper Italy and Germany, while also the Sardinian government is undertaking important works for the improvement of the now free port of Genoa, and the railway thence to Arone, which will be completed in 1850. At any rate, an important rival to the Trieste route has sprung up in that over the Luckmanjier—although both, perhaps, are not worth the old Marseilles route.

THE LONG RANGE.

Speech of Lieut.-General SIR HOWARD DOUGLAS, Bart., M.P., on Lord Ingestre's motion on Mr. Warner's alleged discoveries, July 13, 1846.

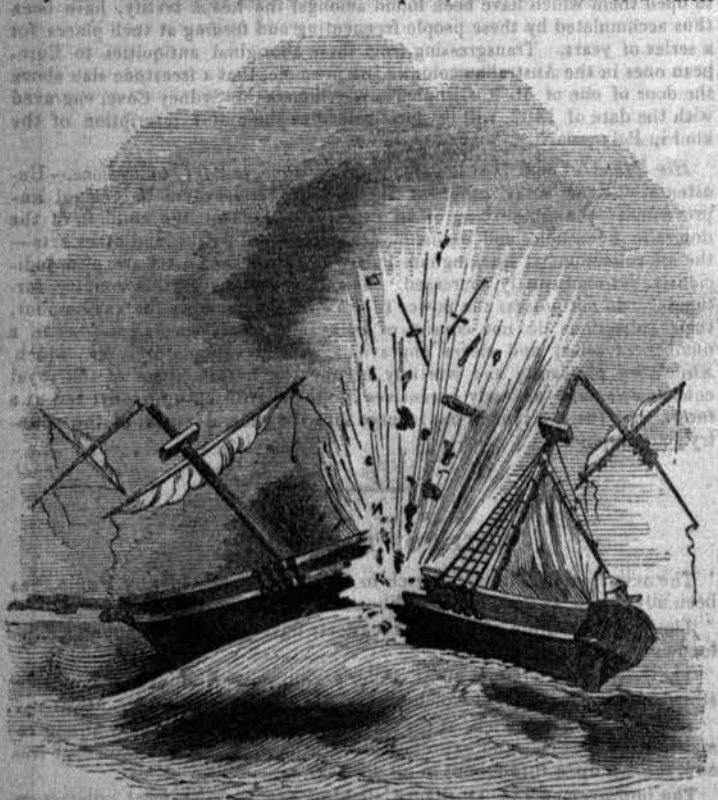
If any one doubts that the "long range" is a gross quackery, we recommend the perusal of Sir Howard Douglas's speech. Mr. Warner has said a great deal about official persecution, but we understand it now in another sense. Here is a gallant general, a highly accomplished member of his profession, forced to undertake a most unpleasant public duty, as a commissioner of enquiry into this "long range," and he is obliged to get up and defend himself in parliament, and to publish his speech, by way of making a kind of weapon against any future attacks. Sir Howard's exposure of Warner is complete, while his professional remarks on explosive power are very interesting; and as the subject is very little understood, we shall take the liberty of making a few extracts from the speech and notes. It will be observed, that before receiving any intimation as to the nature of the invention, Sir Howard Douglas expressed in the following speech, the opinion that a balloon was the essential feature of it:—

"Mr. Warner asserts a power which sets the most important laws of nature at defiance. Gravitation, by which the system of the universe is maintained—resistance, by which some of the most benign purposes of Providence are accomplished, are nothing to Mr. Warner. When Colonel Chalmers, a member of the late commission, cautioned Mr. Warner of the prodigious powers of resistance to his long range, he exclaimed, 'Who can frame laws to govern a force which has never before been heard of—a force a hundred times greater than that of gunpowder!' More was urged by the colonel, but, as he says, Mr. Warner was too dogmatical to reason with. Who can frame laws to control such a force as Mr. Warner imagines? Why, the Almighty Maker of the universe. . . . It is pre-

cisely because Mr. Warner's alleged projectile force is, as he says, a hundred times greater than that of gunpowder, that it would be met by a resisting force greater in an increased ratio, by which the projectile would be opposed, controlled, and reduced to moderate velocities and limited ranges. We possess in gunpowder greater force than we require. We reject the random use of it to gain accuracy. The power by which one of the cliffs of Albion was recently blown into the sea, and the Royal George out of it, is more than adequate to any, that war requires, or can be used with advantage in projectiles. The greatest range that ever yet has been attained was by the mortar or howitzer, the trophy that now stands in St. James's Park, which threw a shell filled with lead about three miles into Cadiz, but with such random effect, as to do little or no harm.

"By using the denser metal, lead, that range was procured, and the momentum of the shell, so filled, augmented. A British 13-inch shell filled with lead discharged from a mortar with the full charge, may be projected about as far as the Cadiz mortar threw its shell. I do not say that greater ranges may not be attained. . . . No great increase, even of random range could be obtained, by increasing the magnitude of the gun to almost any size. And even then it would be a random range. . . . My life has been devoted in a great degree to matters of this kind, and I assert, that it is physically impracticable to procure a range of six miles by any projectile force. Mr. Warner first asserted, that his long range was not a projectile, he has since asserted that it is. But it may be a balloon, or a kite: if so it is old, and nothing worth. (It was proposed during the threat of invasion in the late war, to endeavour to destroy the Boulogne flotilla by such agents, but this was laughed at. It is well known that Sir W. Congreve proposed to destroy towns and forts by the aid of kites. They were to be made of canvas, and of a very large size, so as to be able to carry very great weights. When the kite had reached its place of destination, and stood over the devoted fort, camp, or ship, the shell was to be dropped into the midst of the place or vessel.) It may be a compound of projection and propulsion. This were still more ridiculous.

"I do not deny that Mr. Warner may have hit upon some explosive compound more potent than gunpowder, and some improved mode of causing it to explode, either by mechanical or chemical action, but as to the modus operandi, so far from there being anything new in Mr. Warner's process, I hold in my hand a work published at Paris five and twenty years ago,—*'Mémoire sur les Mines Flottantes et les Petards Flottans, ou Machines Infernales Maritimes; par Montgery, Officier de Marine,'*—containing a history of many different modes of blowing up ships by marine fougasses from very early times. This work has for its frontispiece, the destruction of a vessel



'Mémoire sur les Mines Flottantes et les Petards Flottans, ou Machines Infernales Maritimes; par Montgery, Officier de Marine.'

by an invisible shell loaded with gunpowder, which did its work more effectually than in the case of the John o' Gaunt. Mr. Montgery details in this work, different processes for blockading vessels in bays or harbours, by laying down 'torpilles à ligne d'accomplissement,' across their entrances, these torpilles being made invisible by being retained below the surface of the sea by anchors, and connected with each other by lines, so that no vessel

could pass, without coming in contact, either with a torpille, or with the line connecting one with another, causing both to collapse, strike the vessel, and explode. Mr. Montgery likewise details the process by which a vessel in chase of another may be destroyed by the use of two torpilles, connected to each other by a line,—'Vessels of all sizes, but above all steam-boats, may make use of these torpilles connected with each other by lines. A vessel may even sink another by torpilles connected with each other by lines. Vessels or boats chased by superior forces, may deliver themselves from their enemies, by throwing into the sea one or more of these mines flottantes connected with each other. The operation of shutting up an enemy's port, ought to be executed at night, otherwise the enemy having knowledge of it, would easily frustrate the attempt.'

"It were easy to adduce from Mr. Montgery's work, and many others, abundant proofs that there is nothing new in the proposition for submarine mines, as suggested by Mr. Warner. We find the following in Pepy's Diary:—

"In the afternoon come the German de Knuffler to discourse with us about his engine to blow up ships. We doubted not the matter of fact, it being tried in Cromwell's time, but the safety of carrying them in ships. But he do tell us, that when he comes to tell the king his secret, for none but the kings successively, and their heirs' (to this Mr. Warner adds prime ministers) 'must know it, it will appear to be of no danger at all. We concluded nothing; but shall discourse with the Duke of York to-morrow about it.'

"To these I may add an infinity of names mentioned by Monsieur Montgery from the earliest times. And in our own refer to Bushnel, 1787; Torpedo war and submarine explosions, by Robert Fulton, Fellow of the American Philosophical Society, and of the United States Military and Philosophical Society, New York, 1810; De la machine infernale maritime, ou de la tactique offensive et défensive de la torpille, etc. par M. E. Nunez de Taboada, etc. Paris, 1812; Colt, see New York Weekly Sun; Monsieur Jobart, of Brussels, &c. &c."

IMPORTANT EXPERIMENTAL TRIP.

On Thursday, May 13th, there was a grand day with the steam navy at Woolwich, the Lords Commissioners of the Admiralty having ordered an experimental trip with all the steam-vessels at that station which were in a state of sufficient forwardness for the purpose. The vessels originally appointed to compose the squadron were, the Amphion, 36 guns (300 horse-power); Sharpshooter (iron screw st.); Rifleman (wooden screw st.); Minx (iron screw st.); Teazer (wooden screw st.); Growler (st. sloop); Kite (st. v.); and Princess Alice (iron st. packet). Owing to the arrangements being incomplete, the Sharpshooter and Rifleman did not join the squadron. Between nine and ten o'clock the Lords Commissioners arrived. At ten minutes past eleven the signal was given from the Black Eagle to loose from moorings, and in about ten minutes the fleet started from Woolwich in the following order: Teazer (screw) leading the way, followed by the Amphion, Monkey, Black Eagle, and Kite, and in this order they proceeded down Woolwich Reach, and up the galleons. The Amphion was, of course, the principal object of interest, and upon testing her speed, it was found that with the engines making 45 revolutions, and with her jib set, her rate of speed through the water was 6.8 knots. The Teazer proved to be the slowest boat of the fleet. In Halfway Reach the Black Eagle put on her full speed, and soon came up to the Amphion, and then reducing her engines to half speed, she kept within hail of the Amphion during the remainder of the cruise. Their lordships, who took their station on the paddle-box of the Black Eagle, with Sir J. J. Gordon Bremer, paid especial attention to the Amphion, and signalled to hoist the spanker sail, the wind then blowing stiff from the south-east. The log was again thrown overboard, and the speed with the engines at forty-seven revolutions proved to be 7.8 knots. When the squadron reached Erith, the Minx, which is a faster boat than either the Amphion or Teazer, soon headed the fleet, the Amphion holding on her way, with the Kite on her larboard, and the Black Eagle on her starboard, quarter; the Teazer a considerable distance astern, and the Growler (which had been detained at Woolwich) just bearing in sight. The squadron passed Erith at a quarter-past twelve, and a signal was then hoisted from the Admiralty yacht (Black Eagle) to put on more sail; an order which could not then be complied with, as the wind was unfavourable. In Long Reach, the speed of the Amphion was tried at the measured mile, which was done in 8 min. 52 secs., the tide having just ebbed; this gives a rate of speed equal to 6.766 knots, or about 8 miles, with the engines making 44½ revolutions. As the squadron neared Greenhithe, their lordships boarded the Amphion, and ordered all sail to be set. The spanker, jibs, and topsails were then set, and this vessel, under the conjoint influences of wind and steam, careered rapidly on her way. The Growler, which had continued her course at full speed, here overhauled the fleet, and passing the Amphion to port, took up her station as the leading steamer on the starboard side. The squadron stood on through Sea Reach, where the full operation of both wind and tide was felt; and here the log gave a speed of 10 knots. Having reached the estuary of the Thames, their lordships signified their wish to return, and the Amphion was brought round with great celerity, and they embarked at once on board the Black Eagle. It may be as well to state that this is

London, Brighton, and South Coast Railway Company.—The directors having decided upon the competition designs for the terminus at Newhaven, have awarded the premium of £100 to Messrs. J. W. and W. A. Papworth, of Caroline-street, Bedford-square; and that of £50 to Mr. Martin Stutely, of Gower-street, Bedford-square.

The Hanover and Harburg railway has been opened.

The Croydon Atmospheric System.—The Croydon Atmospheric Railway is at an end! At a Board meeting on Tuesday, May 4, it was determined that the line should be shut up; and this was done forthwith.

Prevention of Oxidation of Metals.—A correspondent of the *Mining Journal*, says—"I have been led to adopt a simple method of coating metals, by the agency of an acid, so as to secure them most efficiently from the deteriorating influence of oxidation. The article to be coated is first dipped in a dilute acid, composed of two parts sulphuric acid and one nitric acid, in nine parts water. After immersion in this solution, the article is to be washed in clean water, and then allowed to drain; and so soon as it appears to be dry, it is to be brushed over with copal or lac varnish; the varnish attaches itself firmly to the acidulated surface of the metal, and never peels off. The best species of varnish for this purpose is probably copal, to which is added a little litharge. I have subjected sheet-iron thus treated to the continued action of sea water for several months, without its sustaining any injury. It is, perhaps, worth while for ship owners to consider whether a considerable economy would not result from the application of this method to the copper sheathing of ships."

Sawing Engine.—At the Royal Institution, April 16, Prof. Faraday called the attention of the members to a working model of a sawing-engine, invented by Mr. Cochran. By this engine wood can be cut into curves of double curvature (i. e., curves in two planes). This is effected by the saw being made to turn on a vertical, while the wood is turned at the same time on a horizontal, axis.

Recent Depressions in the Land.—A paper was read at the Geological Society, Feb. 24, by J. Smith, Esq., on the above subject. Mr. Smith gives the result of careful measurements of the sea-level above the pavement of the famous Temple of Serapis near Pozzuoli. These measurements, made independently in the years 1819, 1826, 1838, 1843, and 1845, by Mr. Smith, Prof. Forbes, and the Chevalier Niccolini, all conspire to prove a gentle subsidence of the land on which the temple stands at a rate of about one inch annually. Mr. Smith gives other proofs of the encroachments of the sea from an engraving in the "Vera Antichità di Pozzuoli," published at Rome in 1652, where the churches are represented as intervening between the three columns and the sea. These churches are washed away, as well as two sea-walls, built one within the other for the protection of the road. Mr. Smith then gives a variety of proofs, historical and geological, of the subsidence of parts of the coast of Normandy, Brittany, and the Channel Islands. The stumps of trees are seen standing in the sea, in spots where, at high water, the sea is 60 feet deep; and Mr. Smith has ascertained, from MSS. of the ninth century in the Library of Avranches, that these forests were tranquilly submerged about that period. Mr. Smith also states, on the authority of Capt. Martin White, R.N., that on the coast of Normandy, lines, evidently artificial, and apparently stone walls, are seen under water running out to sea, and that the lead in sounding on that coast frequently brings up fragments of bricks and tiles, which he is convinced are the ruins of submerged buildings.

Electrical Musical Instrument.—At the French Academy of Sciences, M. Froment presented a little electrical instrument, with a vibrating blade yielding a sound. It is composed of a small electro-magnet of iron, the contact of which oscillates between one of the poles and a stop against which a spring causes it to bear. An electric current, introduced into the apparatus, passes by the contact in iron and the stops in such a way that the circuit is cut off when these two pieces are separated. This last effect takes place when the wire of the magnet is interposed in the circuit; for it then attracts the contact which, in abandoning the stop, interrupts the flow of the current. The magnetic power then ceases, the iron blade pushed by the spring returns to strike the stop, and again closes the circuit. A new magnetic power is again given, and again checked, and all this with great rapidity, so as to cause several thousand beats in a second. By turning the screw which serves to vary the amplitude of the vibration and the immediate force of the spring, the instrument can be made to give out all the sounds upon the musical scale. The instrument being so regulated as to give out a fixed sound, the slightest variations in the intensity of the current employed cause corresponding variations in the sound; and thus the apparatus may be employed to judge of the regularity of the passage of electricity in various instruments used in electrical experiments.

Fresco Painting.—A new method of painting as a substitute for fresco has been discovered by a French artist, M. Chevet. It is called by the author *Fresque Mixturale*, and consists of a composition which effectually resists the action of saltpetre, so fatal to fresco painting wherever there is saltpetre in the walls on which it is laid. The effect of M. Chevet's painting is as bold as that for which it is a substitute, and the colours are as vivid. It possesses not merely the advantage of resisting the effect of saltpetre, but can be washed when dirt or dust has accumulated upon it with quite as much security as oil paintings.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM APRIL 24, TO MAY 18, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

Theodore Hyla Jennens, of Birmingham, manufacturer, for "an improved method or improved methods of manufacturing papier maché articles, also a new or improved method of ornamenting papier maché articles, which said method of ornamenting papier maché articles, is also applicable for ornamental purposes generally."—Sealed April 24.

John Morgan, of East Greenwich, manager, for "certain improvements in machinery, applicable to preparing and spinning flax and hemp, and other fibrous substances."—April 27.

Jonathan Atkinson, of Liverpool, in the county of Lancaster, soap boiler, for "a new method of manufacturing soap."—April 27.

Caroline Watson, of Chorley, in the county of Lancaster, for "improvements in apparatus for filtering." (A communication.)—April 27.

Alfred Vincent Newton, of Chancery-lane, Middlesex, mechanical draughtsman, for "certain improvements in the construction of roads or ways, and in the carriages to be used thereon." (A communication.)—April 27.

Thomas Denne, of Bermondsey, Surrey, strap manufacturer, for "improvements in the manufacture of grease or composition for atmospheric pipes, and for lubricating the axes and moving parts of machinery."—April 27.

John Coates, of Seedley, in the county of Lancaster, calico printer, for "improvements in machinery or apparatus for cleaning the surface of woven fabrics, or freeing the same from fibrous or other loose matters, previous to printing thereon."—April 27.

George Thomson, of Nottingham, cabinet-maker, for "improvements in machinery for sawing wood and other substances."—April 27.

Marie Malanie D'Hervilly Hahnemann, of Rue Clichy, Paris, and Henry Petitpierre, of Place de Chateau Rouge, Paris, for "improvements in instruments for writing."—April 27.

Robert Broad, of Tipton, in the county of Stafford, engineer, for "improvements in railway turn-tables."—April 28.

Richard Archibald Brooman, of Fleet-street, London, for "certain improvements in railway turn-tables." (A communication.)—April 28.

William Carter Stafford Percy, of Manchester, upholster, for "improvements in machinery for making and dressing bricks and tiles, and in certain sheds and kilns in which bricks and tiles are dried and burnt."—April 29.

John Speer, of Gloucester-road, Hyde-park-gardens, gentleman, for "improvements in piano fortes, and in the musical scale of notes in use for such instruments, and also an apparatus to facilitate the action of the fingers on the keys of the piano-fortes."—April 29.

John Elce, of Manchester, machine maker, and Richard Bleasdale, of Rochdale, mechanic, for "certain improvements in machinery for preparing and spinning cotton-wool, and other fibrous substances."—May 4.

William Newton, of Chancery-lane, civil engineer, for "improvements in machinery for letter-press printing." (A communication.)—May 4.

Joseph Taylor, of Tipton, in the county of Stafford, engineer, for "a certain improvement or certain improvements in the construction and manufacture of wheels for railways and other carriages."—May 4.

Gardner Stow, of King-street, Cheapside, gentleman, for "improvements in the construction of steam-vessels, and an apparatus for propelling ships and other vessels." (A communication.)—May 4.

William Henwood, of Portsea, in the county of Southampton, naval architect, for "improvements in propelling vessels, and in steam-vessels."—May 4.

Lemuel Wellman Wright, of Chalford, in the county of Gloucester, engineer, for "certain improvements in machinery, or apparatus, for sweeping or cleansing chimneys, flues, and other similar purposes."—May 4.

Fennell Allman, of Charles-street, St. James's-square, Middlesex, consulting-engineer, for "an improved mode of making, forming, or shaping candles."—May 4.

Conrad Haverkam Greenhow, of North Shields, gentleman, for "improvements in the construction of ships or vessels, and in propelling ships or vessels."—May 4.

John Horsley, of Ryde, Isle of Wight, practical chemist, for "improvements in preserving animal and vegetable substances."—May 6.

Herbert Spencer, of Lloyd-street, Lloyd-square, Clerkenwell, civil engineer, for "certain improvements in machinery, for planing and sawing wood, parts of which improvements are applicable to machinery for cutting certain other substances."—May 6.

Moses Poole, of London, gentleman, for "improvements in apparatus for connecting and disconnecting railway carriages." (A communication.)—May 6.

Charles Fox, of No. 3, Trafalgar-square, Charing-cross, Middlesex, engineer, and John Coope Haddan, of No. 11, Upper Woburn-place, civil engineer, for "improvements in railway-chairs, and switches in trenails or fastenings, and in machinery for preparing railway sleepers."—May 6.

Johann Gassoh Seyrig, of New Lenton, in the county of Nottingham, engineer, for "certain improvements in propelling on land and on water."—May 6.

Isham Baggs, of Holford-square, Middlesex, for "certain improvements in the production and management of artificial light."—May 7.

Joshua Fielden, Esq., of Waterside, Todmorden, in the county of Lancaster, for "an improved mode of laying and pressing cotton, silk, wool, flax, and other fibrous matters, into cans, baskets, boxes, and other depositories."—May 8.

Amos Bryant, of Heavitree, in the county of Devonshire, gardener, and Richard Tot-hill, also of Heavitree, in the same county, surgeon, for "improvements in preparing, constructing, and draining land, and an improved implement or implements to be used therein."—May 8.

William Norman, of Paradise-place, Finsbury, Middlesex, cabinet-maker, for "improvements in the construction of expanding or dining tables."—May 10.

John Martin, of Allsop's-terrace, Middlesex, for "improvements in apparatus and means used when draining cities, towns, and other inhabited places."—May 8.

John Tattersall Culliffe, of Manchester, hide merchant, for "certain improvements in pickers, for power looms, and also in the tools or apparatus for manufacturing the same."—May 14.

John Thomas Gray, of Wardour-street, Middlesex, bootmaker, for "an improved boot and shoe."—May 14.

Thomas Shipp Grimwade, of Sheepcote Farm, Harrow-on-the-Hill, Middlesex, for "a new mode of treating milk for purposes of nutriment."—May 14.

Thomas Hazeldine, of Brudenell-place, New North Road, Middlesex, engineer, for "improvements in the construction of furnaces."—May 18.

Richard Peyton, of the Bordesley Works, Birmingham, metallic bedstead manufacturer, Jonathan Harlow, of Bordesley Works, aforesaid, and Thomas Horne, of the Borough of Birmingham, brass-founder, for "improvements in the manufacture of bedsteads."—May 18.

THE NEW PALACE OF WESTMINSTER.

THE HOUSE OF LORDS.

With an Engraving, Plate X.

Architecture is pre-eminently a royal art—princes, pontiffs, and prelates have paid more direct homage to it than to any other of the fine arts. In the palmy days of Christian architecture—ere its decay was insulted by the mongrel abortion which we call Classic—the spoils of conquerors, the revenues of rich churches, the votive treasures of pilgrims, the dowries of king's daughters, the gains of merchants and burghers, the tribute of provinces, were not considered contributions too munificent for the erection of those stupendous edifices which adorned every town and city of mediæval Europe. In our own country, from the time when the Saxon Ethelbert founded the abbey of St. Augustine at Canterbury, till Henry the Seventh reared the magnificent chapel at Westminster which bears his name, zeal, wealth, and power had scarcely any other historical records but palaces, colleges, and cathedrals. Architecture seems to have been a ruling and pervading idea in the minds of the people of those times. The mailed knight, returning from the wars, made it his chief care to adorn the abbey adjacent to his castle—or, at least, to found a costly chantry in which prayers might be made for him when departed. Rival monasteries strove with all their energy to outvie each other in the magnitude and decoration of their edifices; their brethren travelled far and wide to levy contributions; and every art which zeal and experience could suggest, or superstition and credulity render available, was put in requisition.

All this took place in days when competition designs and tenders for building by contract were not yet invented. The common people shared in the architectonic enthusiasm of their superiors. There were more penalties than golden pieces among the offerings: and they who were too poor to give even pence, freely bestowed their labour—felled trees, quarried stone, dug earth, carried burdens, and considered no task too toilsome, so that they might be gladdened by seeing their beautiful church rising, day after day, before their eyes. It was a sorrowful sight when the work stood still because of war or for lack of means. The pride taken in the task by these men, who were the lowest and humblest that lived in what have since been called the Dark Ages, is now so entirely out of date—so utterly unlike any modern popular feeling—as to seem incomprehensible, and almost improbable. To them the great fabric, as it gradually towered above their cottages, and became the way-mark of the country round, was the chief boast and glory of their native place: and if they might only see with their own eyes the wondrous work at length accomplished, which had slowly grown beneath their hands and the hands of their fathers, and, perhaps, grandfathers before them,—then, indeed, their highest ambition was accomplished. These poor men were very spendthrifts in their love of the Beautiful.

Much of this feeling doubtless was due to the prevailing influence of the church and religious or superstitious motives. But even after making a liberal allowance on this score, a great deal remains which is only explicable on the supposition of a general enthusiasm for noble architecture. The religious bodies themselves had little to gain by the mere decoration of their edifices: they, at least, must have been sincere in their masonic zeal; for had their churches been as hideous as meeting-houses in modern manufacturing towns, or as contemptible as genteel chapels of ease in fashionable watering-places, their own condition would have remained unaffected. They ministered in no way to their personal luxury or love of ease in adorning buildings destined for no private or secular uses. Neither could the laity have been animated by selfish motives alone;—the hope of absolution, indulgence and easy exemption from penance, could not have sufficed alone. The unanimity of purpose throughout widely separated countries, its continuance for centuries in succession, and its universality among all grades and classes, sufficiently show that not external inducements alone, but internal feelings also, must have been in operation. The internal feelings which influenced these votaries of art were chiefly—a strong love of home, an honest ambition for the honour of their birth-places, and a fond desire to raise up something in their familiar haunts which might draw the wayfarer and stranger out of their road, to marvel at its exceeding beauty and excellence.

Accordingly, their architecture was of home-growth and contemporary

—it was essentially their own. These men were neither cosmopolitans nor archaeologists: they sought neither for exotic importations nor for resuscitated antiquities—had no craving for things removed by either time or distance—read too little to care for the one, travelled too little to attain the other.

It is a long while now since their beautiful architecture fell into decay, and was succeeded by a strange fantastic style—the mingled production of many ages and climates. This medley, as strange as was ever seen in an old curiosity shop, which grew fashionable in England only after architecture became the exclusive luxury of the rich, has been lauded in all the set phrases of the dilettanti, from the reign of Queen Elizabeth to that of Queen Victoria. It has, therefore, been a most happy chance for the Fine Arts, that this confusion of antagonistic principles, exhibited during that long period, in the public edifices of England, has at last been checked, and that in offering designs for so vast and important an edifice as the New Palace of Westminster, the competing architects were restricted to two styles which, whatever their imperfections, possessed in a great degree these essential elements of architectural truth—indigenous growth and the subservience of decoration to construction.

The style actually adopted by Mr. Barry—the Perpendicular—is, of the two styles to which the designs were restricted, the one which most fully satisfies the tests in question. It is not only English, but exclusively English. The change of architecture, after the Decorated period, took in this country a form altogether different to that exhibited in the contemporary change of foreign architecture; so that it is all but absolutely true that the Perpendicular style is not to be found out of England. Again, the style was a faithful one—it involved none of the absurdities arising from the incongruous combination of arches and horizontal architraves. All encomium of the new building, should therefore, as it seems to us, commence from this point—that it develops on a grand scale, for the first time in modern public edifices, the principle of architectural truth. Columns, arches, piers, and buttresses are employed not merely to be looked at, but to contribute each its due share to the support of the building. It is true that this principle has some exceptions. Large iron girders are employed in the construction; and though all attempts to apply modern mechanical skill to the legitimate purposes of art tend to the benefit of art itself, yet it must be confessed that the consistent adaptation to an ancient English style of mechanical appliances so entirely unknown to our ancestors as were cast iron girders, involves considerable difficulties. Among the few exceptions to our commendation of the constructive faithfulness of the architecture of the New Palace must be mentioned certain arch-heads formed by single stones. These stones are to all intents *beams*, and to cut them into the shape of arches is to deceive the eye by an affectation of forms without purpose.

The interior of the House of Lords corresponds well to the character of the external architecture. We find the same rich profusion of elaborate details, the same multitude of rectangular panels, the same minute and careful study of the decorations. The old architects deemed the composition of their buildings the first point for consideration to which the elaboration of minor parts was to be kept subordinate: but the visitor to the House of Lords must not expect any of that massive, bold combination of simple parts by which the older architects produced effect, even with restricted means. Everything here is rich, graceful, and delicate. The severest of critics could not discern one offence against good taste. But there are no towering columns, dark vaulted roofs, piers that seem to have been reared by giants, and broad deep masses of shadow, such as are found in the adjacent ancient building.

The drawing herewith shown is the first of a series, which we propose to give illustrative of the new Houses. It is merely an outline, and must not be considered as giving any adequate idea of the effect of decoration—for every little panel there shown is filled up with carvings and other enrichments, which we shall hereafter give in detail. A work so large as is the House of Lords, so profusely and so minutely decorated, cannot be represented by any drawing which is less than the size of the original; for there is certainly not a square foot of surface, which has not been placed under the hand of the decorator. Our engraving has, by the great kindness of Mr. Barry, been made partly from our own admeasurements and partly from drawings, and we shall endeavour to give a record of this valuable work, which may be received as authentic.

The House of Lords is a double cube of 45 feet, that is to say, 90 feet in length, and 45 feet in breadth and height. It may be considered as consisting of three parts—the southern or throne end, the northern or bar end,

and the middle or larger portion, in which are the woolsacks, clerks' tables and seats of the peers.

The House is lighted by twelve windows, six on the west and six on the east; the latter side is the one shown in our drawing. At each end of the House are three archways of the same dimensions as the windows. At the throne end these arches are filled up so as to receive fresco paintings; at the north end they are recessed for galleries.

We shall confine ourselves at present chiefly to the description of the sides. It will be seen that the side forms three tiers, the two lower of which are of oak panelling, and are divided by a projecting gallery. The lower tier is divided into twenty-four compartments or divisions, three under each window, and one under each pier. This lower tier is formed into panels, four high, with a coved panel or canopy under the gallery. The three lower ranges of panels are of the "napkin" style, with V.R., an oak leaf, and crown intertwining in the corners of the folds of the drapery. The fourth range has an ogee arch, crockets, and finials, the arch being divided by quatrefoils and tracery, with a flower ornament at the bottom. The compartments are divided by a pillar bearing a bust. The busts form a series of the English kings. Between the busts is an inscription, in Tudor characters of "God save the Queen" in openworked letters. Above this and below the canopy is a pierced brattishing of trefoils. The canopy is supported by moulded ribs, springing from the pilasters. Each panel of the canopy bears the emblazoned arms of one of the Lords Chancellor of England. The series begins with Adam, Bishop of St. David's, in 1377, and extends to Lord Cottenham, the present Chancellor. The arms of the sovereigns, also richly emblazoned, serve to mark each reign, and to form a chronological division.

The front of the canopy is moulded, having a treillage in the lower moulding. The pendants are carved, and bear a lion's head, above which is the brass railing of the gallery. The lower part of the brasswork consists of roses intertwining. The rest of the brasswork is chiefly twisted. The knobs are enamelled in colour and gilt, and serve to relieve and set off the brasswork.

The gallery only contains one row of seats, intended for peeresses, and is entered by a number of small concealed doors in the panelling under the windows.

The upper tier of panelling is very rich indeed. It is divided on a different plan from the lower panelling, as will be seen from our plate. The upper panels are filled with labels bearing "God save the Queen," upon a ground of vine leaves and grapes in relief. The pillars dividing the panelling are slight and are elegantly carved. They support a cornice decorated with pateræ and embattled. Above this again is a brattishing of trefoils, interspersed with finials corresponding to the pillars below.

The windows are each of eight lights, divided by mullions and transoms, and the upper range of lights subdivided and filled in with quarterfoil tracery. The windows are to be filled with stained glass. On the splay of the jambs the inscription "Vivat Regina," is painted many times, the words being separated by quarterfoils, alternately blue and red.

Between the windows are niches with canopies, in which are to be placed statues of the Barons who signed the Great Charter. The pedestal is supported by an angel bearing a shield, on which is emblazoned the arms of the Baron. The interior of the niche is diapered, but the canopy, pillars, &c., are gilt. Above the niches spring the spandrels, to support the arched ribs of the windows and the ceiling, being filled in with quarterfoil tracery, richly gilt. On the fascia around the House is inscribed repeatedly the motto, "Dieu et mon droit."

Chromatype.—The most interesting process of photography appears to be that of the Chromatype, discovered by Mr. Robert Hunt. It consists in washing good letter paper with the following solution:—Bi-chromate of potash, 10 grs.; sulphate of copper, 20 grs.; distilled water, 1 oz. Papers prepared with this are of a pale yellow colour; they may be kept for any length of time without injury, and are always ready for use. For copying botanical specimens of engravings nothing can be more beautiful. After the paper has been exposed to the influence of sunshine, with the object to be copied superposed, it is washed over in the dark with a solution of nitrate of silver of moderate strength. As soon as this is done a very vivid positive picture makes its appearance; and all the fixing these protographic pictures require is well washing in pure water.

REVIEWS.

The Tradesman's Book of Ornamental Designs. By SAMUEL LEITH. Part I. London: W. S. Orr.

The progress of ornamental design in this country has created its own circumstances; it has now its own artists, its own societies, and its own literature. Whereas, when we began our labours in this Journal, it was difficult for a gentleman to get his house decorated—and then only under foreign superintendence and with foreign assistance; in consequence of which, very few persons of competent means gave any encouragement to decoration: now, as in the case of the Baron de Goldsmid's mansion in the Regent's Park, the most admirable designs can be executed by English aid alone. We are convinced that had the High Dutch party been allowed to have their own way, and to surrender the decorations of the Palace of Parliament to Cornelius and the Munich people, the present progress of the arts in England would have never taken place; and we feel gratified that we were among the earliest to oppose the attempt, and to claim a fair trial for Englishmen on their own ground. We do not regret that we then exerted ourselves, and we may say confidently that every effort that has been made of late years to forward the cause of art, has been fairly met, and that there is every encouragement for future exertion.

Mr. Leith is an artist at Edinburgh, connected with the Board of Trustees for Manufactures in Scotland, and he has been led to bring forward a cheap collection of drawings suitable for tradesmen, with the view of spreading a better knowledge of style and purer elements of taste. In this first number there is, among the examples, some excellent iron work, particularly perforated railing. The carved stand, which is called Flemish, does not seem to us to have any impress of style. An Italian study of angels, from a drawing made by Guido Reni, after an earlier master, is admirable. There is an Elizabethan vignette. We know that a work of this kind is wanted, and we think that Mr. Leith is likely to prove successful. We shall therefore watch its progress attentively.

General Table for Facilitating the Calculation of Earthworks. By F. BASHFORTH, M.A., Fellow of St. John's College, Cambridge. George Bell, Fleet-street.

A table for the calculation of earthworks, of sufficient generality to include all cases—and at the same time of easy application—has long been a great desideratum among engineers. The two tables which have been hitherto employed are those of Bidder and Macneill; the great objection to the former is the number and labour of the operations required, and to the latter that they are not sufficiently comprehensive. Neither of these objections apply to Mr. Bashforth's system, which is very simple and easily applied—and moreover has this advantage, that it includes the case of sidelong cuttings. The tables, with the scale for proportional parts, are not much more bulky than those of Mr. Bidder: the mode of using them we now proceed to describe.

Suppose two cross sections, a chain apart, to be made through a railway cutting; and first suppose that the slope on either side is unity, and the heights of the opposite banks equal at the same section, but uniformly decreasing from end to end. If now we suppose the inclined planes to be produced, they will meet in a straight line below the formation level; and the figure included between the two vertical planes of the sections a chain apart, an inclined plane through the summit of the banks, and the inclined planes of the banks, will be a portion of a pyramid. If, moreover, a and b be the vertical depths of the line where the planes of the banks or slopes meet below the summit of the cutting at the two sections, the volume

of the portion of the pyramid will be $= \frac{22}{27} \{a^2 + ab + b^2\}$ cubic

yards. If, now, the slope, instead of being $= 1$, had been $= r$, the

volume would have been $= \frac{22 \cdot r}{27} \{a^2 + ab + b^2\}$ cubic yards; and if

the distance between the terminal sections had been d chains, instead of one chain, the above quantity must have been multiplied by d . In order to find a and b , suppose h and h' the heights of the portion of

cutting at the two ends measured from the formation level; c the breadth of the formation level; and r the slope:—then

$$\frac{c}{2r} + h = a; \quad \frac{c}{2r} + h' = b.$$

But the quantity of earthwork is equal to the volume of the above frustum of a pyramid, minus that portion which lies below the formation level; and this latter portion is a prism, bounded by two triangles at the ends, the areas of which are, for a slope 1, $(h-a)^2$; consequently, if L were the length in chains of such a prism, its cubic contents would be $\frac{22}{9} \cdot L (h-a)^2$; and for a slope r $\frac{22r}{9} \cdot L (h-a)^2$:

∴ the quantity of earthwork taken for L distances, a chain apart, and a slope r would be

$$r \cdot \Sigma. \frac{22}{9} (a^2 + ab + b^2) - \frac{22r}{9} L (a-h)^2.$$

In Mr. Bashforth's tables, $\frac{22}{9} (a^2 + ab + b^2)$ is tabulated for all integer values of a and b , from $a=0$ to $a=65$, and $b=0$ to $b=65$; and a scale of proportional parts is added, to extend the calculation to decimal parts of a foot.

Example for Equal Distances.

To show how to use the tables, we will take out the following example, working it first by Mr. Bashforth's, and then by Mr. Bidder's, method:—

Heights from formation level at distances a chain apart, 30, 40, 25, 35; breadth of formation level, 30 feet; slope, $1\frac{1}{2}$ in 1.

MR. BASHFORTH'S METHOD.

To find the quantity to be added to each of the heights, divide half the base by the slope: then $14 \div 1\frac{1}{2} = 8$. Adding this quantity to the heights, and taking the corresponding figures from Mr. Bashforth's table, we have the following scheme:—

Heights.	Tabular Numbers.
38, 48	4540
48, 33	4055
33, 43	3550
	12145

Subtract $\frac{22}{9} \times \text{length (3 ch.)} \times \text{square of the additional height (8)} \dots\dots 469$
11676
 $1\frac{1}{2}$ (the slope)
20433 cubic yards. (Ans.)

MR. BIDDER'S METHOD.

Heights.	Tabular Numbers	
	for centre.	for slopes.
30, 40	85.6	3015
40, 25	79.5	2628
25, 35	73.3	2220

238.4 7863
28 (base) $1\frac{1}{2}$ slope
6675 13760
 6675

20435 cub. yds. (Ans.)

Example for Unequal Distances.

In the last example the sections were supposed to be taken at every chain: If, however, we take the sections at unequal distances, the difference between Mr. Bashforth's method and Mr. Bidder's is more apparent. In both, the tabular numbers have to be multiplied by the distances; but as there are two tabular numbers in Bidder's table for every distance, the number of multiplications is doubled.

Let the sections be taken at distances 3, $2\frac{1}{2}$, 2, 1, chains, respectively. Let the heights be 40, 30, 20, 15, and 10. The slope $1\frac{1}{2}$ to 1; the base 25 feet.

MR. BASHFORTH'S METHOD.

The addition to the heights is half $25 \div 1\frac{1}{2} = 10$. Making the

addition, taking the numbers from the table, and multiplying by the corresponding distances, we have

Heights.	Tabular Numbers.	Distances	Products.
50, 40	4970	3	14910
40, 30	3015	$2\frac{1}{2}$	7537
30, 25	1854	2	3708
25, 20	1243	1	1243

84 27398
Subtract $\frac{22}{9} \times (10)^2 \times 8\frac{1}{2} \dots\dots 2077$
25321
 $1\frac{1}{2}$ (slope)
31651 (Ans.)

MR. BIDDER'S METHOD.

Heights	Tabular Numbers.		Distances	Products.	
	Centre.	Slope.		Centre.	Slope.
40, 30	85.6	3015	3	256.8	9045
30, 20	61.1	1548	$2\frac{1}{2}$	152.7	3870
20, 15	42.8	754	2	85.6	1508
15, 10	30.6	387	1	30.6	387

525.7 14810
25 (base) $1\frac{1}{2}$ (slope)
13142 18512
 13142

Total cub. yds. 31654 (Ans.)

Macneill's method does not, like the above, give a general table for all slopes and bases and any combination of them, but a number of special tables of particular slopes combined with particular bases. This method not being general, it would require not a volume, but a library, to contain tables of all combinations of slopes and bases which occur in railway practice. The cases above taken (for example) are altogether omitted in Macneill's tables. But wherever these tables do apply, the arithmetical operations are nearly the same as Mr. Bashforth's: and consist in multiplying the tabular numbers by the distances, and adding the results.

The great value of Mr. Bashforth's tables is the scale of proportional parts; for the mode of using this, and likewise for the calculation of earthwork in sidelong cuttings, we refer the reader to the next number of the Journal: we cannot, however, dismiss the subject even temporarily, without expressing our conviction that Mr. Bashforth's tables are by far the most simple and generally useful of any that have yet appeared;—such we know is the opinion entertained by men who have for years past been engaged in the computation of earthworks, and, consequently, are best qualified to appreciate the value of tabular modes of shortening the labour of calculation.

The Hand-book of the "Sounder;" or Theoretical and Practical Treatise of the Sounder (or Borer).—Guide du Sondeur, &c. By J. LEGOUSSEE, civil engineer. Paris: 8vo.; with maps. 1847.

The work of M. Legoussée treats of every subject relating to borings for underground works, and although there has been no lack of detached papers on this head, the work before us comprehends the whole of the facts and reasoning hitherto known. After having briefly sketched the history of the subject, the author proceeds to the geological portion of the doctrine, and first defines what is to be called a geological basin. He describes, then, the aspect of secondary and tertiary basins in different countries, and examines the most favourable localities for the boring of artesian wells, the strata of fossil fuel, rock salt, mineral waters, &c.

After these preliminaries, our author enters on the description of the different systems, and the different applications of sounding; the explanatory apparatus for the study of the ground; the driving of piles, and placing of poles for telegraphic lines; mooring stones, and foundations for suspension bridges; submarine boring for the removal of shoals and reefs, and the improvement of bridges; horizontal boring, and other mining operations—ventilation, and absorbing pits for the draining or absorption of fetid waters; in fine, on artesian wells and the search for underground water.

After having dilated on the different modes and systems of boring, the work passes to the description of the different boring apparatus—as instruments for clearing and emptying, correcting apparatus, instruments for boring horizontally, or for boring in the angles of walls, &c. The author then details several contrivances for tubes and repairing damages, and inserts a journal of a boring operation, indicating with great accuracy the progress of the work through different formations; the accidents which might have intervened, and the remedies resorted to to repair and prevent them. A recapitulation of the results hitherto obtained by boring, and what may be accomplished, follows, and the author concludes this chapter by the description of some instruments which are indispensable for ascertaining the extent and quality of work performed in any given time. The means for obviating the decrease in the flow of artesian wells, as well as absorbing pits suffering under stoppages, are then given. The work concludes by fixing attention on the especial laws of geology and mechanics, which it is indispensable for the borer to know, and for securing a proper execution of the many works in which boring is now used. The plates form a very useful and interesting accessory to this deserving work.

Carpentry in Divisions of A, B, C. A Comprehensive and Useful Work. By PETER NICHOLSON. In Twenty Parts. Part I. London: Weale.

This is the first part of a new issue of Peter Nicholson's work, with additional plates, and many promised improvements. The work seems likely to be what it is styled, "comprehensive and useful;" but we hope that the redundancy of Mr. Nicholson's style will be carefully pruned, and that unexecuted designs (such as the verandah by Mr. Arundale) will not be published. Mr. Nicholson's practical plates are very good, but his descriptions of them are apt to run to too great a length.

Post Office Railway Directory for 1847.

With the growth of railway kings, directors, and members of parliament, it becomes desirable to know who they are—which is, we suppose, the reason for the present work, which gives an alphabetical list and biography of all these functionaries. Thus we have sketches of the Stephenson, Brunel, Locke, Hudson, &c., and as the book ministers to public curiosity, it will in all probability be a standard. We notice a list of railway engineers and mechanical engineers, with the appointments they hold.

Architectural Maxims and Theorems. By THOMAS LEVERTON DONALDSON, Professor of Architecture, University College. London: Weale, 1847.

Mr. Donaldson has published a small work, which consists of two parts—a collection of maxims, and a lecture on the character of architects. It is a work remarkable enough to deter us from reviewing it at the late period at which we have received it.

THE DEE BRIDGE FAILURE.

Considerable interest has been caused among the profession through the failure of a cast iron girder bridge over the River Dee, near Chester, which took place on the 24th May last; and in consequence of the accident involving the death of some individuals, a coroner's inquest has been held, which lasted several days. It not our intention to give the whole of the evidence, as much of it was extraneous; but we shall select those portions which immediately apply to the construction and failure, and then offer some remarks of our own, together with a wood-engraving of the girder, showing the fractures, and a section.

Mr. THOMAS ALFRED YARROW, who was selected by the coroner and jury to examine the bridge, said,—I have been a civil engineer for the last 12 years. I have held the appointment of bridge-master for Chester for some time, and have no connection at present with any railway. I have made an examination of the railway bridge over the Dee, and I now read my report of the inspection:—

Report.—"Upon examining the bridge, I found that the masonry and ironwork, with the exception of that part of each which has fallen, were in an apparently sound state. The principle of the bridge is that of trussed girders of cast metal resting upon stone piers and abutments, which are parallel to the course of the river, but askew to the railway

above. Each girder consists of three pieces, having vertical flanges, with bolts at the joints, and, in addition to being bolted to the full depth of the girder, each joint is surmounted by a segmental piece, to receive which, notches have been cast in the upper surface of the girders. The tension rods descend in an oblique direction to each joint, and are carried horizontally between them; they consist of separate bars of wrought iron, which are secured to each other laterally by clips. The portion of the bridge which has fallen consists of one outside girder on the Saltney side of the river, with the attached platform and transverse tension rods. Two stones, composing part of the string course, and acting as a bed for the girder on the Saltney abutment have fallen, and also the corner stone at the acute angle of the opposite river pier upon which the broken girder rested. The girder itself is broken, having two fractures in the length near to the Saltney abutment, and one in its centre. Having premised this short description of the construction of the bridge, and its present appearance, I may proceed to detail the facts which I have remarked during my investigation, and which have enabled me to arrive at a confident conclusion as to the cause of the accident. My attention was in the first instance directed to an examination of the fractured ends of the girder, for the purpose of ascertaining whether any defect had existed in the castings. The appearance of the broken surface led me to conclude that the castings had been sound, and the tension bars, as far as they have yet been recovered from the water, are unbroken.

"From calculations which I have made of the strength of the girders, taken from an actual measurement of the section at the point of fracture, I find that, independent of any additional strength that may be obtained from the tension bars, the girders alone are capable of sustaining a much greater weight than could under any ordinary circumstances be placed upon them. The breaking weight of each girder I calculate at 74 tons, supposing the weight to be concentrated over one point, and of both girders 148 tons. But it is an admitted principle that a beam will carry twice the weight, distributed over its whole surface, that it will bear upon one point. We can therefore conclude, that twice the above weight, $148 \times 2 = 296$ tons, is the breaking weight of one bay or opening of the bridge for one line of rails. The weight of girders and platform is, at a rough calculation, about 90 tons, which must be deducted from the foregoing quantity; we have therefore 296, less 90, equal 206 tons as the breaking weight; and this is altogether without reference to the tension bars.

"From the above facts, I concluded that the accident did not arise from the breaking of the girder as a primary cause, and I therefore directed my attention to the state of the masonry and to a consideration of its sustaining power. Having carefully examined all the displaced stone and their respective beds, I found that one, previously named as forming the acute angle of the river pier, and upon which one end of the broken girder rested, was totally inadequate, in its form and bearing surface, to its important situation. This stone had sustained nearly three-quarters of that portion of the flange of the girder which rested upon the pier. The area of its lower surface is 24 ft. 6 in., of which 11 ft. 6 in. only was bedded on the pier, leaving 13 ft. to overhang as a cornice. The stone was not connected by cramps or ties with the adjoining masonry of the pier. The railway over the whole bridge is curved. The broken girder supporting the outer side, and being subject to a greater lateral force than the girders forming the inside radius of the curve, I consider that this lateral force, acting during the passage of each train, must have so far loosened the inefficient masonry as to cause a displacement of the girder itself and its consequent fracture."

Mr. ROBERT BOARD, superintendent of the Mauseley Iron Works.—The girders of the Chester railway bridge over the Dee were manufactured at those works. They were tested before sent to the railway. Each girder was placed side by side and tested by 50 tons of iron being put on them in the centre. We took the deflection on every five tons, but have not got the particulars of those deflections. The ordinary pressure on the girders passing over them would not exceed 50 tons. After the girders had been tested we found a flaw in one of them: it was a mere honey-comb, and it was rectified before it was sent away. I have since examined the girder, and found that the accident had not resulted from the flaw. The fractures were in the sound metal. I superintended the fixing of the girders. There are many railway bridges of the same kind. On the Trent Valley line there are eight of the kind. It is not opened to the public as yet, but on the Blackwall railway there are several that have had heavy trains passing over them for years. The one over the Dee is the largest. I never heard of any of them giving way. Had been several times to view the bridge when trains were passing over it, and found the deflection very trivial, not much more than an inch.

Major-General Sir CHARLES WILLIAM PASLEY.—I was the Government Inspector-General of Railways when the Chester and Holyhead Railway was opened. I surveyed the bridge over the river Dee on October 20th, and reported it as safe. I compared the plans with the actual building, and examined it in such detail as I deemed necessary. It is an iron girder bridge, of three openings or spans of 95 feet each; wrought iron tension rods are used to strengthen it. I always was of opinion, and am so still, that these tension rods are not of great use, because I consider that the expansion of wrought and cast iron from heat differs in some degree, although not very greatly; but that iron girders being very massive and the tension bars thin and of small dimensions, the sun may act on the wrought iron rods very considerably and less on the cast iron girders; and supposing them to be adjusted for a moderate temperature, the intensity of hot weather may destroy their proper proportion and do away with the benefit of

the tension. I may here state that wrought iron, when acted upon, will elongate considerably without breaking, but cast iron will not without breaking. There have been a number of bridges of this description erected on railways in various parts of England, both before and after I held the appointment of Inspector-General of Railways, none of which, with the exception of this one, ever failed. They were not quite of the same extent, but I will allude to a cast iron girder bridge at York, over the river Ouse, of the York and Scarborough Railway, which has two openings of 70 feet span. The least depth of the iron girder on that bridge is 3 feet. The least depth of those on the Dee bridge is 3 ft. 9 in.; and as the bridge at York and other similar bridges have stood, I concluded that this one would, as it had an extra depth. I may also mention another bridge over the Tees, at Stockton, although I have not seen it. I may vouch for what I state to be correct. It has a span of 83 ft. 4 in., and the least depth of iron is 3 feet.

Mr. R. STEPHENSON said it was 87 feet.

General Pasley.—I thought it was what I stated, but you may be correct. The flange on this bridge is greater than on others. I have frequently mentioned to engineers that wrought iron tension rods would do little good. In my inspection of a cast iron girder bridge, on the Syston and Peterborough Railway, built by Mr. Liddle, the resident engineer, I found that he had omitted tension bars, and in my report to the Earl of Clarendon I approved of the omission, and considered it a preferable construction. It appeared that Mr. Liddle could not get the tension rods in time, and therefore he built the bridge without them. Having mentioned this repeatedly to engineers, and having been given to understand that Mr. Bidder and Mr. Gooch have made experiments with a view of testing the strength of girders without rods, I am informed that the trial was in favour of the latter. As to the cause of the accident;—it has been stated that some time after the Shrewsbury and Chester railway was opened, and after I had inspected it, a girder was cracked, and was replaced by a new one. This circumstance, which I did not know, and which was never reported to government, coupled with the fracture of this one, induces me to think they are not safe, and that it is the mere cast of a die between their safety and danger. I consider that the tension rods are of very little use indeed. The tension rods are connected with the girder alone, as if they were part of it. They have no independent support, and there is a difference between this bridge and Mr. Stephenson's former iron girder bridges. In all his former girder bridges there is a connexion from girder to girder, on the central pier or piers, from one end of the bridge to the other, so that when the pressure is on one girder, the other girder in the same line contributes to assist. That is the case with the one on the river Ouse at York. The horizontal portion of these bars appears to be useless. The oblique tension bars would be of use if the upper ends were fixed to some independent support to each pier, and similar independent support on each abutment, and if the standards or support over the abutments had tension bars extending inland to resist the heavy weight going over the extreme bays or openings of the bridge. There is a swing bridge over the river Wensham, at Norwich, strengthened on this principle, and which is extremely judicious. In this case I consider that the girder broke on a train passing over, added to the weight of the ballast that had been thrown on it in the course of the morning. The masonry gave way from the girder breaking, and from that cause alone. I examined the girder; and the castings seemed very good, and I believe it is generally admitted that they are good; but the girder was too weak after the ballast that was put upon it. The girder was far enough in the masonry to support it. There was quite bearing enough to render it secure. I do not think the engine driver suddenly putting on the steam would cause the engine to bound with such force as to break the girder. I saw nothing to throw the carriages off the rails on the bridge, which had strong guard rails. I should say that no girder could have withstood a deflection of $5\frac{1}{2}$ inches. It would have broken short at once. A continued deflection of 4 inches must have broken it long before this occurred.

Mr. ROBERT STEPHENSON put in a written report on the accident; from which it appeared that on the day it occurred, and only a few hours previously, he had narrowly inspected every part of the bridge, and saw nothing to indicate weakness. He had carefully examined into every circumstance connected with the disaster, and for reasons which he gave, was satisfied that it arose from a violent blow against the girder, near to the abutment on the Saltney side, caused by the train getting off the rails. The report said:—

"It has been suggested that the unequal expansion and contraction of the girder, during great changes of temperature, might probably interfere with the uniform strength of the metal. It is impossible to deny that this circumstance does sometimes interfere with the strength of cast iron beams, but generally this influence may be regarded as confined to castings where the thickness of the different parts vary considerably. In the present case, the form of the castings was carefully studied, and with only such small deviation from absolute uniformity in all thicknesses of the different parts of the section, as practice has long proved to be justifiable.

"With regard to the competent strength of the structure, I concur generally in the deduction drawn by Mr. Yarrow, in which I am confirmed by an extensive experience in the construction and use of similar structures, tried under circumstances that demonstrate their capabilities to meet all the ordinary contingencies of railway traffic."

Mr. JAMES KENNEDY, of the firm of Bury and Kennedy, Liverpool, was recalled, and confirmed the opinion he had given at the last meeting as to

the probable cause of the accident. The girder might have given way either from a blow, or the extra weight of ballast and the train on it. Cast-iron girders were capable of sustaining in the centre 70 tons; but if the tension rods were not perfectly adjusted, he did not think the bridge safe for ordinary trains. He did not think damp ballast placed on the bridge would affect the temperature of the girders so as to cause them to break.

Mr. H. ROBERTSON, the engineer of the Shrewsbury and Chester Railway, was next called, and said—I have examined the bridge since the accident. My opinion is that the bridge broke under the weight of the engine and train, increased to a large extent by the laying down of 25 tons of ballast on the platform just previous to the accident. The witness then handed in a lengthened report which he had made to the Directors, respecting the failure of the bridge, in which he stated that the fracture spoken of by Mr. R. Stephenson, as having been produced by a lateral blow, was, in his opinion, caused after the girder had fallen, and that the fracture which caused the bridge to give way was that in the centre. He considered that the tension-rods tended more to weaken the girder than to strengthen it.

Mr. Robertson then read the following report which he had made to the Directors of the Shrewsbury and Chester Railway:—

"I minutely examined the Dee bridge on the Chester and Holyhead Railway on the occurrence of the accident, and have since examined repeatedly the points which bear upon the accident. I have caused drawings to be prepared and also a model, showing the details of the structure and the fragments of the beam, in so far as now discovered; and to these I would refer you, instead of attempting to give a written description of the bridge. (These were produced in Court, for the inspection of the coroner and jury.) You will perceive that there are two principal fractures in the beam—one near the centre, $5\frac{1}{2}$ feet from the west abutment, in the middle portion of the girder; the other in the portion of the girder next to the abutment, and 20 feet from its 'fence.' The latter fracture appears to me, from its form, and especially from the position in which the fragment lay, as shown in the ground plan taken the morning after accident, to have been caused by the fall; any disturbing cause previously to the fall is quite inconsistent with the close proximity of the fragments. The fracture at the centre, from the position of the fallen portion, and of the middle tension-rod wrapped over the girder, and especially from the form of the fracture, appears to me to have first taken place. This fracture I consider to have resulted from the weakness of the top flange, which was compressed and broken by the strain arising from the rolling weight of the engine and tender, and the vibratory motion of the structure itself, increased to a large extent by the deposit of 25 tons of ballast on the roadway immediately before the accident. This compression is remarkably evident by the bulging out of the metal at the point of the parting at the top of the web, or vertical portion of the girder.

"In estimating the strength of the girder, I am of opinion that the tension-rods, from the form of the section of the girder, weakened it, and threw an undue strain, by compression, on the top flange; but, assuming that they did not weaken it, and applying the formula, as given by Eaton Hodgkinson, F.R.S., to the girders—by one formula, the breaking weight is equal to 61½ tons; and, by the other, the breaking weight is equal to 76 tons. Now, it has been an established rule in practice, that one-third or one-fourth of the breaking weight is the safe working weight to which a girder should be subjected, and the larger the size, the smaller ought to be the proportion; taking, therefore, one-fourth of 56 (the breaking weight), it follows that the safe weight to which one of the girders ought to be subjected is 18½, and the two girders 37 tons. The weight of the timber, platform, beams, rails, chairs, &c., exclusive of the girder, according to an approximate calculation I made, is 19 tons 6 cwt.; and, adopting the rule that a uniform weight is diffused over the beam, is equivalent to one-half that weight suspended at the centre, this becomes equal to a weight suspended at the centre of 9 tons 13 cwt. The equivalent weight of an engine and tender of 33 tons 10 cwt. 2 quarters, suspended at the centre of the beam, I estimate at 32 tons—making a strain of 41 tons 10 cwt. against 37 tons—the safe working strain to which the bridge ought to be subjected. However, on the afternoon of the accident, immediately previous to the passing of the train, the bridge was subjected to an additional strain, by the laying on of 5 inches of broken red sandstone ballast, amounting to a weight over the bridge of 25 tons, which is equivalent to a weight suspended at the centre of 12 tons 10 cwt. This makes a total of 54 tons against the safe strain of 37 tons formerly stated; and the last addition appears to me to be the immediate cause of the accident. In these calculations, however, it is assumed that everything is at rest, and that the forces applied are those resulting from direct pressure, whilst the evidence shows that there is a vibratory movement of the whole structure to a large extent; and there is, besides, a percussive movement of the engine and tender, which, with a heavy long-boiler engine, with outside cylinder, is considerable.

"The weight of the structure, and of the train in motion, will be about 164 tons in all, and the strain from this cause must be added to that formerly stated. This strain, although it cannot be ascertained by accuracy of calculation founded on experiment, experience shows to be great; and I am of opinion that it formed a large element in the strain which broke the bridge down. There is also the whole gross strain arising from the pressure and the percussion of the structure and its load, with the apportionment of that strain between the girders; for I am of opinion that, from the loose and independent connection of the girders, and the giving of the structure, the strain may have been unequally divided between the girders. These investigations, independently of the evidence of the eye-witnesses,

lead me to the conclusion, that the girder broke in the middle from its weakness to resist the strain, increased by the laying on of the ballast.

"The opinions of Mr. Stephenson and Mr. Locke, founded on the alleged facts as to the paint on the tender, the broken carriage-wheel, and the snips in the chairs, appear to fall to the ground, as they must have been misinformed on those particulars, which can all be disproved.

"HENRY ROBERTSON, Engineer."

"Chester, June 15, 1847.

Captain Symonds, R.E., and Mr. Walker, who were retained by Government to examine into the cause of the accident, presented to the inquest a very lengthened report, the following are extracts from it:—

"That the bridge was of sufficient strength if the cast and wrought iron be supposed to act together, each taking its equal proportion of the strain.

"That there is great difficulty in insuring the joint action, and that if this is a part of the principle of the bridge, we do not approve of it.

"That neither the wrought nor the cast iron, taken separately, was sufficient for perfect stability; and that, to have insured this, the cast iron girders alone should have been of sufficient strength to carry the whole weight, with an ample allowance for the various circumstances (some of them peculiar to this bridge) which we have explained.

"That, with the exception of the bends, or warps in the top flanges, the castings are of good quality. That the wrought iron is also of good quality.

"That the stonework of the piers and abutments is good; and in no way contributed to the failure.

"We now come to the question, what was the immediate cause of the accident? As the bridge had carried as great or greater loads before, the suggestion that there was something peculiar in this case, as the end of a rail having projected from the straight line and been struck by the engine, or the tender having got off the line and struck the girder laterally, is not improbable. The engineers who were called by the Railway Company considered that the breaking of one leaf of the wrought iron that was next the tender, the piece that was struck out of the girder, and the damage to the abutment wall, are all proof of the fact that the accident was caused by the tender having got off the line, and broken the girder by a heavy lateral blow. We refer to the evidence of Mr. Robert Stephenson, Mr. Locke, Mr. Vignoles, and Mr. Gooch, who were also of opinion that the strength of the girder was sufficient. As to this latter point, we have already stated the principles upon which alone this conclusion could have been arrived at, and our own opinion. As to the tender or the carriage immediately behind it having got off the railway and damaged the abutment walls, there is no doubt; and if the tender struck the side of the girder, when the latter was under great strain, a fracture was the probable consequence. This is on the presumption of the tender having got off the line from some other cause than the breaking of the girder.

"Our own decided opinion, formed from the statement we have made as to the strength of the girder, and from the position in which the broken pieces were found, the two halves being each in a straight line, or nearly so, but at an angle with one another, is that the first fracture took place in the centre of the girder, and not at the end which rested on the abutment.

"In corroboration of this last view, the addition that was made to the permanent weight of the bridge, immediately before the accident, by the ballast spread over it, and the fact that when a weight, partly permanent and partly passing, but which together formed a considerable portion of the breaking weight of the girder, are in continual operation, flat girders of cast-iron suffer injury, as their strength becomes reduced; and if, when this has taken place, the momentum of the passing weight is increased by an irregularity of the rails, or in the motion of the engine, to which the best made and managed railways are subject, a fracture is likely to follow. The probability of this having been so in the present case, and the fact of the tender having been off the line, and having been drawn up with great violence, so as to break the end piece of the girder by the blow, are to be weighed against each other in assigning the cause of the accident.

"Having reference to other cases, it is proper to state that Mr. Robert Stephenson stated in his evidence that he had erected a number of bridges on the same principle as this, and that this was the first failure. We have not examined these bridges; they are stated to be all of a less span than the Chester bridge, but that the dimensions of the parts are proportionally less; and it may perhaps be argued from the above numerous examples, and the opinions of the eminent engineers opposed by this one failure, that we are mistaken in considering the weakness of the girder to be the cause of the failure in the present case, and unnecessarily cautious in the objection we entertained, and have expressed, as to the principle of this bridge and its security; but, as we entertain these opinions very decidedly, it is our duty (by no means an agreeable one) to express them."

"The Verdict of the Jury.

After an hour's deliberation, the foreman, Sir E. Walker, returned the following as the unanimous verdict of the jury:—

"We find that George Roberts, John Matthews, and Charles Nevitt, were accidentally killed on the evening of the 24th of May last, in the parish of St. Mary-on-the-Hill, in the city of Chester, by being precipitated along with a train of carriages on the bank or bed of the river Dee, from the breakage of one of the 12 cast iron girders constituting the railways-bridge over that river.

"We find also that Isaac Powis died on the 26th of May from injuries

he received at the same time and place, and from the like cause; and we find that Thomas Anderson came by his death on the 24th of May last, in the parish aforesaid, by being accidentally thrown from the tender on to the rails.

"We are further unanimously of opinion, that the aforesaid girder did not break from any lateral blow of the engine, tender, carriage, or van, or from any fault or defect in the masonry of the piers or abutments; but from its being made of a strength insufficient to bear the pressure of quick trains passing over it.

"We feel that the 11 remaining girders, having been cast from the same pattern and of the same strength, are equally weak, and consequently equally dangerous for quick or passenger trains as was the broken one.

"We consider we should not be doing our duty towards the public if we separated without expressing our unanimous opinion, that no girder bridge of so brittle and treacherous a metal as cast iron alone, even though trussed with wrought iron rods, is safe for quick or passenger trains; and we have it in evidence before us, that there are upwards of 100 bridges similar in principle and form to the late one over the river Dee, either in use or in the course of being constructed, on various lines of railway. We consider all these unsafe, more or less, in proportion to the span; still, all unsafe.

"We therefore call upon her Majesty's Government to institute such an inquiry into the merits or demerits of these bridges, as shall either condemn the principle, or establish their safety to such a degree, that passengers may rest fully satisfied there is no danger, although such bridges may defect from $1\frac{1}{2}$ to 5 inches."

The Coroner stated that that portion which related to the death of the deceased could only be taken as their verdict. Their recommendations, however, he would forward to the Railway Department of her Majesty's Government; and no doubt the press would give them due publicity.

The bridge crosses the Dee river at an angle of about 48° , and is constructed with three spans—skewed to the same angle—of 98 feet each in the clear; each span being sustained by four trussed girders, 109 feet long, one on each side, and two in the middle, making the two roadways independent of each other; on the inside of the bottom flange of each pair of girders, shoes are cast, having a dove-tailed socket, into which wrought iron cross ties are fitted, to secure the girders from springing outwards at the bottom. Between these, and resting upon the same flange, are strong timber bearers or joists, upon which a flooring of four-inch planks is laid; on this the longitudinal sleepers are fitted, carrying the rails and check-rails, the latter being continued 26 feet beyond the span of the bridge each way.

The train passing over the bridge at the time of the accident consisted of the engine and tender, following which the carriages were arranged—1st. One first-class: 2nd. One second class (with break and guard-box): 3rd. One second: 4th. Luggage-van: 5th. Second-class.

Each girder is in three lengths of cast iron, bolted together at the joints, making 109 feet in length and 3 ft. 9 in. in depth, and surmounted over each joint by a connecting scarfing, 13 feet long and 3 feet high. The clear span of the bridge is 98 feet, and the bearing 5 ft. 6 in. at each end.

The width of the top flange is $7\frac{1}{2}$ inches, and thickness $1\frac{1}{2}$ inch on the edge; thickness of the web $2\frac{1}{2}$ inches; width of lower flange 2 feet by $2\frac{1}{2}$ inches thick. The top section, including the molding on the underside, contains 14 square inches; the lower flange and molding 66 square inches, and the web 80 inches: making in all 160 square inches. On each side of the girder there are four wrought iron tension bars, 6 in. by $1\frac{1}{2}$ in, the collected section of the eight bars (four on each side) contains 60 inches. The bars are put together in lengths, as usual for suspension bridges; and at the joints of the cast-iron beam, a wrought iron bolt passes through the eight thicknesses of wrought iron bars and the cast iron girder. To this cross-bolt are suspended two other bolts, which pass through the cast iron dovetailed plate, under the joints, and secured on the underside with screws and nuts, to bring the plate up taut to the flange; and the ends of the suspension bars at the abutment are secured to a cast iron raising piece by cross keys.

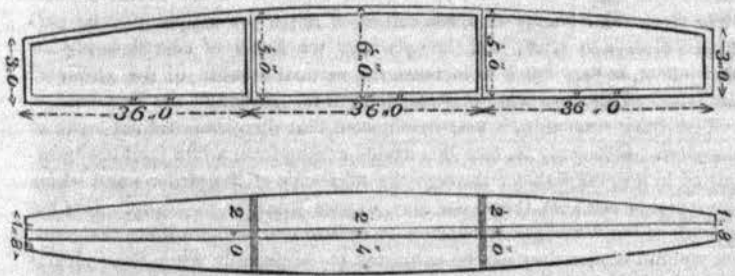
It will thus be seen that the girder consists, in section, of a cast iron girder (similar in form to fig. 2) and eight thicknesses of wrought iron suspension bars: these wrought iron bars, from the very flat angle at which they are set and secured to the cast iron girder itself, seem to be a very poor safeguard against the breakage of the cast iron. In fact, on account of the tension bars being inclined at such a small angle, that a displacement of the particles of the cast iron girder, quite sufficient for fracture, would have produced scarcely any extension of the wrought iron bars, and, therefore, hardly called into play any resisting force from their tension: the tension-rods, in short, were of about as much service to the girder as a piece of pack-thread passed from end to end. The scarfing

pieces being placed over the joint, also appear to be injudiciously arranged, and are not so good as when an increased depth is given to the casting at the joints, as adopted in some other bridges.

The annexed wood-engraving (fig. 1) is an elevation of a portion of the broken girder; part of one of the lengths, which was not broken, is cut short for want of space. The abutment end of the girder is that portion which laid on the Saltney abutment, and had a bearing of 5 ft. 6 in. on the masonry. There are two fractures—one in the length nearest to the Saltney abutment, and which was of considerable extent, 3 ft. 8 in. wide at the bottom, the fracture running along the web, just on the top of the lower flange, and then upwards in a slanting direction on one side and perpendicular the other side. Fig. 2 is a section of the iron at this fracture, which shows two bolt holes at the top, made for fixing on an eagle ornament, and doubtless considerably weakened the girder, as at these bolt holes the flange was found to be completely crushed. From the appearance of this fracture, upon the whole, we are inclined to assign it as the part that first broke. The other fracture is nearly in the centre of the middle length of the girder, and takes a diagonal direction across the girder upwards, to the extent of 4 feet horizontally.

From experiments that have been made since the accident, the deflection of the girders under different loads is from 1 to 2 inches—the greater the velocity of the train the greater is the deflection: this shows that we must not fix the proportions of a girder at three times the breaking weight; but considerably more must be allowed—it ought to be at the least four, if not five, times.

The question that suggests itself, from the failing of this bridge, for consideration among engineers, is whether a girder, containing the same quantity of metal of wrought and cast iron together, 140 square inches in the section, could not be better arranged than the one before us, so as to form the requisites of crossing over a road or river without interfering with the headway below. From the best consideration that we have bestowed upon the subject, we are induced to adopt a girder of the proportions and form shown in the annexed engravings, figs. 4 and 5. The flanges at the joints



Figs. 4 and 5. Elevation and Plan of Proposed Girder.

to be wide, and of the form shown in fig. 3, and the surfaces planed; the connecting bolts to be of as large a diameter as the metal flange will allow, the lower bolts being at least $2\frac{1}{2}$ inches diameter; particular attention must be paid to the fixing of these bolts, and the keying of them, to prevent the nuts loosening by vibration.

According to Hodgkinson's formula* ($W = \frac{2 \cdot 166 \cdot a \cdot d}{l}$), the breaking weight of the Dee Bridge girder is 60 tons—that is supposing the tension bars to be of no service; whereas, the breaking weight of our proposed girder is 110 tons, and contains four tons less metal than the Dee Bridge trussed girder. The weight of 110 tons is, as near as can be, the strength required for the Dee Bridge span of 98 feet, which will be equal to 220 tons for a pair of girders: taking a fourth of this weight as the safe strain, it will give 55 tons. The calculated strain upon the girder at the time of the accident was 54 tons.

It is the joints of these girders that require the especial attention of the engineer, as we shall next proceed to show.

* W weight in tons, a the area of the lower flanges in square inches, d the total depth of the girder in inches, and l the length in feet in clear of the bearings.

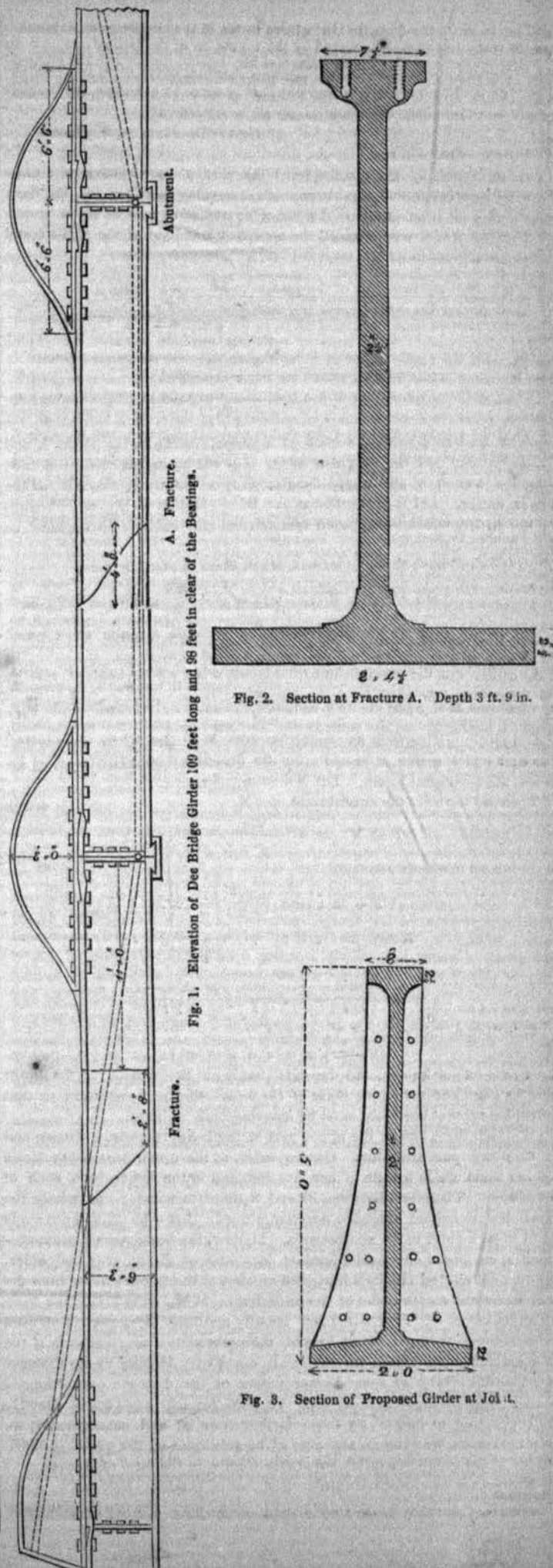
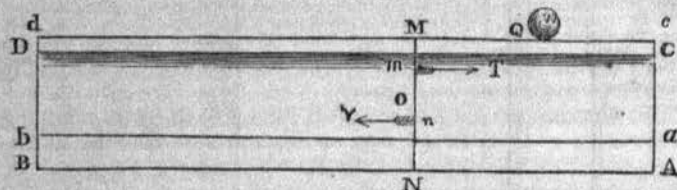


Fig. 2. Section at Fracture A. Depth 3 ft. 9 in.

Fig. 3. Section of Proposed Girder at Joint.

The cause of the fracture we believe to be, that the girder was jointed, and that due consideration was not given to that circumstance in assigning their relative proportions to the flanges. As the effect of a joint is one that practical men are apt to overlook, we propose to examine the subject in detail—excluding as much as possible symbolical language, in order that our reasoning may clearly be apprehended. It is well known that there are usually three distinct divisions of a girder, consisting of the upper and lower flanges and the web: the vertical and transverse section of such an arrangement would resemble somewhat an H laid on its back—thus Π . The reason of this mode of construction will be better understood when we have determined the nature and amount of the strains and thrusts experienced by the several parts of a loaded girder.



Let $ABdc$ be a vertical section of a girder, resting on the points A and B , and loaded with the weight w at Q . Let $cQ = a$; $cd = l$; $Bd = b$; cD , the section of the upper flange; Cb , of the web; and aB , of the lower flange. Let $R =$ reaction at A ; $R' =$ reaction at B ; $w' =$ weight of the girder, which is supposed symmetrical and uniform throughout its length.

Then we shall have these equations, when there is equilibrium—

$$wa + \frac{w'l}{2} = R'l; \quad w(l-a) + \frac{w'l}{2} = R'l.$$

Let us now suppose a vertical section to be made through some point, M , of the girder. Let $cM = h$; $Cc = c$; $Aa = d$.

Consider now the equilibrium of the part cN : cN is kept at rest by the reaction R at A , by its own weight $\frac{w'h}{l}$, and by vertical and horizontal forces arising from its connection with MB : let Y be the vertical force; t and t' acting at m and n , in the directions indicated by the arrows, the horizontal forces. Let $Nn = x$, $Nm = x'$:

Then we have for the equilibrium of cN

$$R + Y = w + \frac{w'h}{l}; \quad t' = t;$$

also, taking moments about A ,

$$Yh + tx = wa + \frac{w'h^2}{2l} + t'x'.$$

$$\text{Now, } t = t'; \quad R = \frac{w(l-a) + \frac{1}{2}w'l}{l}$$

$$Y = w + \frac{w'h}{l} - R = \frac{wa}{l} + \frac{w'(2h-l)}{2l}.$$

Substituting this value of Y , we find

$$t(x' - x) = \phi(a, h, l, w, w');$$

$\therefore t(x' - x)$ is known, and depends simply on the weight of the beam and its load, and *not on the shape of the beam*—the only condition to that effect being, that the beam shall be *longitudinally* uniform.

We find, then, that at the upper part of the beam there is a thrust, and at the lower part a tension. Consequently, at the upper part the particles of the beam are in a state of compression, and at the lower in a state of extension. Therefore, between M and N there is some point where the particles are neither extended nor compressed. Let o be this point: o is said to be a point in the neutral axis. If, now, the beam were laminated—that is, composed of parallel laminae, incapable of sliding over each other, and which obeyed Hooke's law—the amount of the forces arising from the extension and compression of the particles in MN , would vary as their distances from o . This is the law usually assumed for materials of even a crystalline texture; at all events, the probabilities are, that even if the tension and compression do not in all cases vary directly as the distance from o —they vary as some higher power of the distance: according to either supposition, it is clear that the particles near o are not so effective in supporting w and w' , as those farther from it; and, consequently, we see the reason why the greater part of the substance of the girder is distributed at the greatest available distance from o , in the form of flanges.

In the case of a cast iron girder like that of the Dee Bridge, it is not necessary to make the upper flange as thick as the lower one, because cast

iron exerts a much greater force for compression than it does for extension to the same amount, and bears a much greater crushing than rending strain. Suppose now MN to be a joint, and the connection to be effected by means of bolts let through projecting lips, as was the case in the girder that broke;—the question immediately arises, how would that effect the thrust and strain on the upper and lower flanges? Before we consider this question, it will be advisable to show that in the molecular connection, first noticed, $x' - x$ is either or very nearly a maximum; and, therefore, y either or very nearly a minimum—for $y(x' - x)$ is a constant, as we proved.

In the first place, taking the usual law—and supposing the girder not flanged, but uniform, $x' - x$ would be $\frac{2}{3}Ac$; but when we consider

the flanges, the resultants of the strains and thrusts will be thrown much nearer to N and M respectively; and with the ordinary proportions observed

for the flanges and web, $x' - x$ would not be less than $\frac{4}{5}Ac$, or $\frac{4}{5}MN$

—and it is difficult to conceive any mode of connection at MN which could make it greater. We cannot, then, suppose that y can be increased; let us, therefore, suppose that y is the same for all modes of connection.

If, instead of the ordinary law, we had assumed any other law for the amount and variation of the thrusts and strains, involving a higher power of the distance from o than the first, (for instance that adopted by Mr. Hodgkinson) $x' - x$ would on such a supposition be still more increased. On the whole, we may fairly suppose y to be constant—certainly not capable of being diminished by any mode of connection.

But although y remains constant, its distribution, both above and below o , will materially depend on the nature of the joint. Suppose, for instance, a single bolt at N ; then this bolt will sustain all the tension—and all the particles about N will be exposed to an enormous rending strain. Again, if, as in practice, when the joint is bolted from M to N , the lip gives and is slightly deflected, and the bolts work loose, then, in order to make up the value of y , more bolts than those between o and N may be in a state of tension, and less of the girder than from o to M in a state of compression; consequently, since the area which sustains the thrust is diminished, the thrust per square inch will be increased. Also, if some of the bolts work looser than others, the bolts which work tightest will be in the highest state of tension. Some of these causes of imperfect action may be presumed always to exist; and the only way we know of compensating for their effect, is very much to increase the vertical breadth of the girder at the joint. This, however, was not done in the girders of the Dee Bridge.

To all this reasoning, it may be objected that the girder did not break at the joint. Our reply is, that the strains arising from a bad joint are transmitted to a great distance through the substance of the girder—and where the metal is weakest, there we may expect fracture to ensue. It is not enough to build bridges calculated to endure two or three times the greatest statical strains they can be subjected to—especially when those strains are to be supported by cast iron girders. The continual vibration to which iron is liable, tends to weaken the cohesion of its particles: the alternate expansion occasioned by heat and cold has the same effect.

Lastly, it must never be forgotten that the vibration of a train increases enormously the tendency to fracture, by bringing into play dynamical strains, the amount of which is beyond calculation; and that iron bridges are especially adapted to transmit such vibrations.

Artesian Wells in Volcanic Formations.—The first attempts of this kind in Naples were made, some years ago, near the Campo Santo, by the *Società Industriale*; they, however, yielded but a small quantity of water, at a depth of 80 or 90 feet. This led to the great undertaking in the Royal Gardens, which, however, is not likely to yield any favourable result. The deeper the boring proceeds, the harder is the appearance of the strata of volcanic *tuffa*—and the only advantage derived is the perfect knowledge of the geological stratification of the terrain of Naples, on which the architect, M. Cangiano (who superintends the work) read a paper at the meeting of Italian *scienziati*, in 1845. As the supply of water for the metropolis (especially near the Posilippo and Vomero) is constantly on the decrease, government will be obliged to erect new aqueducts at an enormous expense, and to convey fresh water from Monte Taburno, or the sources of the Sarno—or even so far as the Tifetini and Trebulini mountains, near Capua. It may be said with certainty, that the volcanic terrain near Naples does not contain a sufficient quantity of drinkable water for its increasing population—even if it be not the case, that the quantity of water is yearly decreasing, for reasons not yet properly ascertained.

HISTORY OF ARCHITECTURE IN GREAT BRITAIN.

A Brief Sketch or Epitome of the Rise and Progress of Architecture in Great Britain. By JAMES ELMES.

"Epitomes are helpful to the memory, and of good private use."

SIR HENRY WOTTON.

(Continued from page 170.)

It has been already mentioned that Inigo Jones had improved his taste by studying the works of Palladio and other eminent Italian architects, in Italy. It is not unlikely that he had met Sir Henry Wotton at Venice, as this tasteful connoisseur and elegant illustrator of the Vitruvian art was then ambassador from James I. to the Doge. James's brother-in-law, Christian IV., King of Denmark, who had heard of Inigo's reputation from that city of lakes and palaces, introduced him to the British monarch, who immediately appointed him his architect.

Jones's style, after his return from Italy, bears marks of much improvement in taste and purity, as may be seen in the works he executed before his visit to that fostering country of the arts, and those which he designed after his return. This eminent architect visited Italy twice, and enjoyed the friendship and patronage of the celebrated Earl of Pembroke, and other tasteful nobility of the period.

Among his works not already mentioned, are additions to Lord Pembroke's seat at Wilton, the porch of which had been designed by Holbein. Jones's classical additions to this edifice are apparent, particularly the triumphal arch and its equestrian statue, that has been lately cited as an authority, among others, in the controversy about Matthew Wyatt's colossal statue of the Duke of Wellington, in Piccadilly. Also, the quadrangle of St. John's College, Oxford, another proof of his want of feeling for the beauties of Gothic architecture, as is the Chapel Royal, St. James's; Coleshill, in Berkshire; Cobham Hall, in Kent; and the Grange, in Hampshire.

Before concluding that portion of our notice that terminates with Inigo Jones, we must revert to some of those less known artists who flourished between the great days of the Tudor style and the expulsion of arts from England by the rough-shod founders and supporters of the Commonwealth.

Whatever may have been the intentions of James I. as to the erection of a splendid palace for himself and his successors to the crown of the two kingdoms, which had been first united in his person, he had strong objections to his example being copied by his nobles. Fearing that if they made their establishments in the metropolis too large and expensive, it might rob the provinces of much of their grandeur, and the country people of their natural protectors, the wealthy aristocracy of their respective counties; he therefore issued edicts against the enlargement of the metropolis, and confirmed the royal will of his predecessor, Elizabeth, that no further mansions or noble residences should be erected but upon ancient foundations. Lord Bacon informs us, that King James was wont to be very earnest with the country gentlemen to abandon London for their country seats; and that he would sometimes say to them: "Gentlemen, at London you are like ships in a sea, which show like nothing; but in your country villages, you are like ships in a river, which look like great things."

Although James attempted to drive his opulent subjects from the metropolis to their country residences, few of our monarchs had a greater number or more splendid palaces in London than the successor of Elizabeth, from whom he probably inherited this dread of palatial rivalry by his nobles in the metropolis. That powerful queen, who was one of the most absolute monarchs in our history, issued several proclamations, rigidly forbidding the increase of new buildings in London. James did not content himself with merely reproving and exhorting his nobles and magnates, but issued several proclamations to the same purport.

In 1605, when he had been but two years upon the throne, he issued the first of these mandates, which forbade all manner of building within the city, and a circuit of one mile thereof. Among its commands was the salutary one to a wooden metropolis, that all persons henceforward should build their external walls and windows either of brick or stone. The classical reading of the king, who delighted to be compared in wisdom to Solomon, and in the patronage of literature and art to Augustus, probably wished to vie with the Roman emperor in the boast of having found his metropolis of wood, and leaving it of marble (stone). The reason given

in this proclamation for building with brick and stone is, "as well for decency, as by reason all great and well-grown woods were much spent and wasted, so that timber for shipping became scarce." James always showed a predilection for the establishment of a powerful navy, both mercantile and warlike, as his founding the corporation of the Trinity House, the cultivation of the royal woods and forests, and this proclamation, testify. This edict produced as little effect as those of his predecessor; he, therefore, issued another, with more stringent penalties, dated October 10, 1607, and on the 16th of the same month, some offenders against it were censured in the Star-chamber, for building contrary to its tenor. By another edict of the same nature, issued in 1614, the commissioners are required to proceed with all possible strictness against every offender of this sort. This had somewhat more effect, particularly as to the mode of building with stone and brick; and from this period may be dated the reformation of the architecture of London, which is so much indebted both to the architect and his royal patron.

The first house of note that was erected in conformity with this proclamation, was one in the Strand, built for Colonel Cecil; after that, one near Drapers'-hall, Throgmorton-street, in the city, is celebrated; another, built for an opulent goldsmith, in Cheapside, opposite to Sadlers'-hall; and one that was built for a leather-seller, in St. Paul's Churchyard, near the north gate of the cathedral, not being in conformity with the king's regulations—being built of timber—was ordered to be taken down, and rebuilt according thereto.

Among the principal mansions of this period, are Hatfield, in Hertfordshire, the seat of the Marquis of Salisbury, and Burleigh, near Stamford, in Lincolnshire, the seat of the Marquis of Exeter, both built in the reign of Queen Elizabeth; and being still in existence, with very little alteration from their original design, are fine specimens of the mixed pictorial style of the Elizabethan period.

James enlarged and improved, in a similar style, Theobald's, near Cheshunt, in Hertfordshire, originally the seat of Elizabeth's great prime-minister, Cecil, Lord Burleigh, who often entertained his royal mistress within its walls. It was a favourite residence of King James, and was the scene of his last moments. It afterwards became the abode of Richard Cromwell, who retired thither after his resignation of the protectorate of England. He passed the remainder of his days in this once royal residence, in peaceful retirement.

Of the principal reformers of taste among the literary men and nobles of the period, the great lord-chancellor Bacon stands in the foremost rank; and his opinions on architecture and gardening are decisive of the character of those arts, which he so much improved, in his days. His maxim, that houses are built to live in, and not to look on, should never be forgotten by the domestic architect; and his description of a palace, in opposition to such huge buildings as the Vatican, the Escorial, and some others, which, he pithily observes, have scarce a fair room in them, is characteristic of the best style of this period, which Inigo Jones, Sir Henry Wotton, and the elegant-minded lord-keeper had so much improved.

That the taste of Jones was influenced by his association in literature and art, with Pembroke, Bacon, Wotton, Ben Jonson, and other eminent Englishmen, as well as with the literati and connoisseurs of Italy, is proved not only by the purer style of his maturer age, but by the unrivalled design for the royal palace, which bears marks of being arranged in the study of the artist, assisted by noble minds, rather than the work of a builder's office, traced by the mechanical hands of architectural draughtsmen.

Bacon's description of what elements an architect should compose a royal palace, with its accessorial gardens, terraces, and courts; royal state, dwelling, and necessary apartments, together with the personal survey that Jones had made, accompanied by men with congenial minds, of the palaces and royal residences of Venice, Florence, Rome, and other parts of Italy, had a powerful effect upon all his designs, and particularly upon that of his unexecuted palace.

The limited space which the pages of this Journal allows to this notice, will not permit the quoting of Bacon's admirable description of a royal palace—not designed for his poetical commonwealth of Eutopia, but evidently for the encouragement of his royal master to commence a palace, which, in two or three reigns, might surpass all the other royal residences in Europe.

Upwards of twenty years ago, the author of this sketch gave Bacon's description entire in the introduction to his Memoirs of Sir Christopher Wren, and said—"This ideal palace would be an excellent task to try the abilities of a young architect to design on paper, and would make an

admirable probationary gold medal study for the more advanced students of our Royal Academy."*

With similar feelings, the accomplished Sir Henry Wotton, who imbibed a pure taste in all the arts by his residence, as James's ambassador, at Venice, joins with Bacon in admitting that architecture is worthy the attention of an elevated mind, and confesses it to be an art that requires no commendation, where there are noble men and noble minds. He says that he is but a gatherer and disposer of other men's stuff (*sparsa colligit*); he yet presents his countrymen with the soundest theoretical doctrines, and the purest ideas of taste in this noble art, which Jones carried so beautifully into practice. In Wotton's preface, he fears it may be said that he handled an art no way suitable to his employments or his fortune, and so may stand charged with intrusion and with impertinency. To the first, he answered, "That though, by the ever-acknowledged goodness of his most dear and gracious sovereign, he had borne abroad some part of his civil service; yet, when he came home, and was again resolved into his own simplicity, he found it fitter for his pen to deal with these plain complements and tractable materials, than with the labyrinths of courts and states; and less presumption in him, who had long contemplated a famous republic (Venice), to write, then, of architecture, than it was anciently for Hippodamus,† the Milesian, to write of republics, who was himself but an architect." To the second, he confesses that his fortune is very unable to exemplify and actuate his speculations in this art, which yet made him rather, from this very disability, take encouragement to hope that his present labours would find the more favour with others, since it was undertaken for no man's sake less than for his own.

Our great architect, Inigo Jones, who stands second to no modern artist in Europe, was, like his illustrious cotemporary, Milton, not only an Englishman, but a Londoner, being born in the neighbourhood of our metropolitan cathedral, to which he had attached the splendid portico that had drawn forth the just eulogium of the tasteful Burlington. He was apprenticed to a carpenter and joiner, who were in those days more of operative artists and carvers than those of the present time. During his apprenticeship, his innate love for drawing and design had sufficient employment; and he obtained, also, a greater knowledge of architectural construction than he could, had he been in the study of one of the painter-architects of the day. He distinguished himself in early life by a general love for the arts of design, and has been much commended for his skill in landscape-painting; and Dr. Chalmers asserts, in his "Biographical Dictionary," that there is still a specimen by him in the latter art at Chiswick-house.

He was destined for higher purposes than or a carpenter's foreman, or a builder's clerk of the works, his talents having attracted the notice of Thomas Howard, the celebrated Earl of Arundel, whose name is immortalized by his inestimable collection of antique sculpture, called after him the Arundelian marbles,—and also of William, Earl of Pembroke, who took him under his patronage, and sent him to France, Italy, and the politer parts of Europe, with a handsome allowance.

After exhausting the classical beauties of ancient Rome, he proceeded through other cities to Venice, then in the zenith of wealth and splendour, whence he was invited, as before-mentioned, to Denmark, by Christian IV., who appointed him his architect. He accompanied the King of Denmark in his visit to James I., the husband of his sister, the Princess Anne of Denmark. On his arrival in his native country, he was appointed architect to the queen, and shortly afterwards to Prince Henry, at whose lamented death, in 1612, he re-visited the classical shores of Italy. He gave such satisfaction to his illustrious patrons, that on his departure from London, the king gave him the reversion of the office of surveyor-general of his works.

On his second return to this country, he entered upon his office, and executed the splendid public works already mentioned as being marked by a greater purity of taste than his former productions. Upon the death of King James, he was continued in his honourable post by Charles I., and was associated in his honourable and tasteful employments with Rubens, Vandyke, Chapman, Sir William Davenant, Daniel and Ben Jonson. He designed and executed buildings, for Rubens, the prince of painters, to decorate with his gorgeous pencil; and scenes, decorations, dresses, and machinery for the most illustrious poets of his time. At the death of Charles I., Inigo Jones adhered to the party of his royal master. He was persecuted and fleeced, as a matter of course, and stigmatised as a malignant. He died in grief, poverty, and obscurity, July 21, 1652, and was buried in the chancel of St. Bennet's Church, Paul's-wharf, London.

* "Elmes's Life of Wren," Part I., p. xxii. 4to. 1823.

† Aristot. Polit. lib. ii. cap. 6.

The brilliant galaxy of philosophy, poetry, and art, which illumined the hemisphere of the Stuarts, with Bacon, Ben Jonson, Davenant, Rubens, and Jones as stars of the first magnitude, set, amidst the clouds and tempests that convulsed the nation, from the first attack upon the monarchy till the Restoration; when elegance again dawned upon the people in the times of the second Charles, which will form the next epoch of this sketch.

Amidst the stars of lesser magnitude that beamed among the cotemporaries and immediate predecessors of Jones, were Girolamo da Treviso, who, like Holbein, practised both painting and architecture—the latter, as an artist, and not as a builder; Richard Lea, an Englishman, somewhat later; and another, named John Thynne, who built Somerset-house, in the Strand, in 1567, in a mixed style of Italian and Gothic architecture. John Shute, an English painter and architect, who flourished in the reign of Queen Elizabeth, was sent by the Duke of Northumberland, his noble patron, to study the art under the best masters in Italy. He published, in 1563, a folio volume of the principles of architecture, as developed in the most celebrated monuments of antiquity. Milezia, in his lives of architects, mentions an Englishman, of the name of Stickles, who flourished about 1596, as an excellent architect. Robert Adams, who practised architecture and engineering, was superintendent of the royal buildings to Queen Elizabeth, and wrote a description of the river Thames, and of the best method of fortifying it against an enemy. In the same period, flourished Theodore Havens, an architect, sculptor, and painter, who affected grandeur on a small scale, and was rich in Italian conceits. He designed Caius College, Cambridge, a fair specimen of the architecture of the age—pedantic, eccentric, affected, and trifling. This college was founded by Dr. Caius, physician to Queens Mary and Elizabeth; and three of its gates are of curious, if not of elegant, designs, being among the first constructed after the Italian manner in England. The first is inscribed, "HUMILITAS," and, as the Gate of Humility, is of low proportions; the second, which is loftier, and embellished with a portico and emblematical figure, is dedicated to Virtue, and is inscribed "VIRTUTIS. IO. CAIUS POSUIT SAPIENTIAE," and conducts to Caius Court and the public schools; and the third, which is inscribed "HONORIS," and is called the Gate of Honour, is of still larger dimensions, and decorated with the various orders of Roman architecture, overlaid with ornaments, in the style of the ecclesiastical monuments of the period.

About the same time, Rodolph Simmons built Emanuel and Sidney Sussex Colleges, Cambridge, and rebuilt the greater part of Trinity College, in the same University.

Bernard Jansen, a painter-architect of the Flemish school, also flourished in the reign of James; he was a disciple of Dieterling, a celebrated architect of the same country, who wrote much on his art. Jansen executed, during his residence in England, the splendid mansion of Audley-End, in Suffolk, and a great part of Northumberland-house, London; but the extraordinary and original façade was designed by Gerard Christmas.

Among the other architects of this period whose names have reached us, are John Smithson, who died in 1648, and who, under the patronage of the Duke of Newcastle, travelled into Italy to improve himself in his art, and to acquire a knowledge of good design. The mansion-house at Welbeck, and the castle at Bolsover, were of his execution. Stephen Harrison must have been an architect of some reputation, as he was employed to design and execute the triumphal arches and other architectural pageantries, erected in London, on the accession of James I. to the throne of Great Britain.

The political struggles that convulsed the reign of Charles I., which began with such flattering prospects for the arts, and which was the epoch of good taste in architecture, has been already noticed. The rulers of the Commonwealth, instead of patronising arts and artists, not only discouraged the living, but destroyed the works of the dead. The destruction of some of the most elegant productions of painting, sculpture, and architecture, by the iconoclasts of the Commonwealth, will ever remain a stigma on the administration of Cromwell: but the reign of Charles II. was favourable to architecture, as much by the dreadful fire which consumed the metropolis, as by the innate love of magnificence and art which distinguished the king and his court.

(To be continued.)

[In the first part of this sketch, in our last Number, page 168, col. 2, line 11 from bottom, for "Tortegiaus," read "Torregiano."]

ON THE CONSTRUCTION OF ARCHES.

A paper "On the existence (practically) of the line of equal Horizontal Thrust in Arches, and the mode of determining it by Geometrical Construction." By WILLIAM HENRY BARLOW, M. Inst. C.E. (Read at the Institution of Civil Engineers. (With an Engraving, Plate XI.)

The supposition of the existence of a certain curve or line, in which the pressure is transmitted throughout the voussoirs of an arch, is not of recent origin. The theory of equilibration, called the Catenarian, of which an account is given by David Gregory (Phil. Trans. 1697), is founded on this basis; but throughout the investigation, it has been assumed necessary to make the line in which the pressure is transmitted, coincide precisely with the form of the intrados of the arch; a condition which is necessary to stability, only when the arch is infinitely thin.

In the theory promulgated by La Hire and Attwood, familiarly known as the wedge theory, or that in which each voussoir is supposed to act as a wedge, it is considered necessary that the pressure should be transmitted, so that the direction in which it acts at each joint, should be at right angles to the surface of contact, which condition is only necessary to stability, when no friction exists between the surfaces of contact of the voussoirs.

But when the thickness of the arch and the friction at the surfaces of contact of the voussoirs, are both included in the investigation, it has been shown by Professor Moseley, in his able and elegant exposition on this subject, that the two conditions above mentioned, become modified, and that in an arch of uncemented voussoirs, the actual requirements to establish stability are,—

First, That the line in which the pressure is transmitted (which he has named the line of resistance), should fall within the thickness of the arch at every joint.

Secondly, That the direction of the pressure, at each joint, should be within certain limits, depending on the friction of the materials employed.

Coulomb, the first writer on this subject, who based his assumptions on data consistent with practice (*Mémoires des savans étrangers*, 1773), considered, with Moseley, that there were two causes of rupture; the first arising from the turning over of certain parts of one voussoir on the edges of another; and the second, from the slipping or sliding of the voussoirs on each other; and although the mode of investigation pursued was totally different, yet the results present a complete accordance with those since arrived at by Professor Moseley, so far as they embrace the same elements of discussion. This remark applies also to the catenarian and the wedge theories; for if the thickness of the arch be considered to be infinitely small, the line of resistance becomes the catenary, and if the thickness be retained and the friction omitted, the line of resistance is analogous with the line of pressure as determined by Whewell in the wedge theory; but though the investigations of Moseley leave little to be done in elucidating the conditions of stability in arches mathematically, yet the deductions have not received that attention from engineers which their importance deserves chiefly from the absence of any decided practical exhibition of their correctness and utility, and also from the investigation being surrounded by too much mathematical difficulty, to admit of ready application.

The analogy before-mentioned, as existing between the line of resistance, the catenary, and the line of pressure of the wedge theory, arises from one governing principle, which is general in these curves, and constitutes the essential element of equilibrium when the only force acting is gravity, namely, that the horizontal forces in any part of the curve are equal to each other; by which it must be understood, that not only must the horizontal force, at any part of the curve, be opposed by a horizontal force of equal amount in the opposite direction, but that the horizontal force is equal throughout the curve. This essential element of any curve of equilibrium, though probably known, has not been pointed out; its mathematical correctness is self-evident, and of its existence practically, as applied to the line in which the pressure is transmitted through the voussoirs of an arch, the following experiments give satisfactory evidence:—

In an arch composed of numerous voussoirs, let their surfaces of contact, instead of being planes, be made curves, as in fig. 1. If the original form of the arch be such that the line of resistance passes through the points of contact, no motion will arise among the voussoirs, on removing the centre; but if the arch be a segment of a circle, or any other form which does not coincide with the line of resistance, the voussoirs will take up a new position, the curved surfaces of the voussoirs rolling on each other, to a certain limit, when they come to rest, and if disturbed from this position (unless

the disturbing force be sufficient to produce actual rupture), they will return to it.*

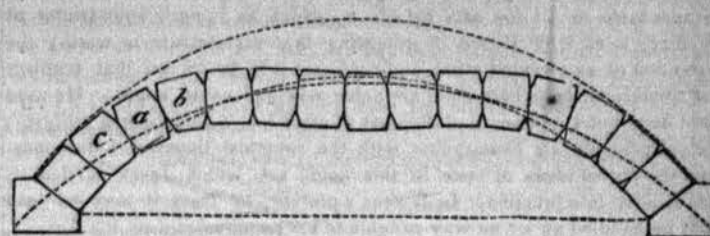


Fig. 1.

In this experiment it is obvious, that the pressure must be transmitted through the points of contact; and it affords a practical proof, that this line is the curve of equal horizontal thrust; for if in any voussoir *a*, the horizontal force at *b*, was not equal to that at *c*, motion must ensue, and as this condition is the same in all the voussoirs, it follows, that the horizontal force is equal throughout. The experiment admits of further application, by loading the arch so as to vary the form of the curve in which the pressure is transmitted, while it of necessity retains the element of equal horizontal thrust; and it will be found, that the limit of stability is when the point of contact of any two voussoirs falls at their outer or inner extremities; thus establishing practically, that the line of resistance, or curve of equal horizontal thrust, must be contained within the thickness at every joint.

The second condition necessary to stability, namely, that the direction of the pressure, at each joint, should be within the limiting angle of friction, is almost always of necessity fulfilled in the forms of arches and with the materials usually employed in practice; this part of the inquiry will therefore be confined to the first condition.

Now the property of equal horizontal thrust, enables a geometrical construction of the curve to be readily obtained in any given form of arch, if two points in the curve be given, and by assuming these two points, it can be ascertained by a tentative process, if any given arch does, or does not, contain the curve.

Proceeding in this manner it is found, that in a semicircular arch, the thickness must be one-ninth of the radius to contain the curve, a result which is completely borne out in practice; for though apparently unnoticed, a semicircular arch cannot be made to stand without foreign support, unless the thickness be greater than one-ninth of the radius.

In like manner, in any other form of arch which does not precisely coincide with the curve of equal horizontal thrust, there is a certain minimum thickness, or depth of voussoir, necessary to obtain stability.

Among various other experiments, made to test the accuracy of the theory, it will be sufficient to give the following. The curve of equal horizontal thrust, when drawn on the elevation of a semicircular arch, of which the thickness is one-ninth of the radius, touches the intrados at 35° above the springing, and the extrados at the crown; and practically, an arch of these dimensions yields, by the crown descending, and the haunches going outwards, the points of rupture, or rotation, being precisely those where the curve touches the intrados and extrados.

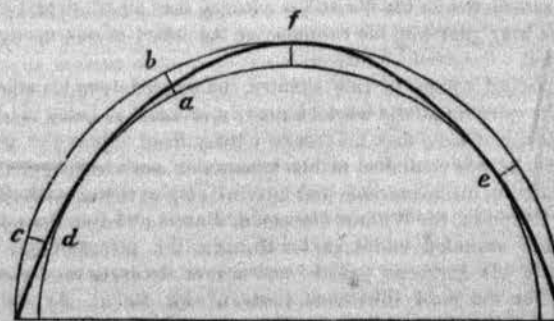


Fig. 2.

* It is necessary that the radius of curvature of the voussoirs be made within certain limits, depending on the depth of the voussoirs and the radius of the arch; if too much curvature be given, the arch will fall, before the points of contact can take up such a position, as to coincide with the line of resistance.

The condition, that the curve must lie within the thickness at every joint was also tested in the following manner. A semicircular arch, of which the thickness was one-ninth of the radius, was constructed in four pieces, having the joints *e* and *f*, fig. 2, at the points of contact of the curve of equal horizontal thrust with the intrados and extrados. A similar arch was also made in six pieces, having the joints at *a*, *b*, *d*, *c*, where the curve lies within the thickness. In the first case, yielding took place, by the crown descending and the haunches going out, and in the second, though composed of a greater number of pieces, perfect stability was obtained.

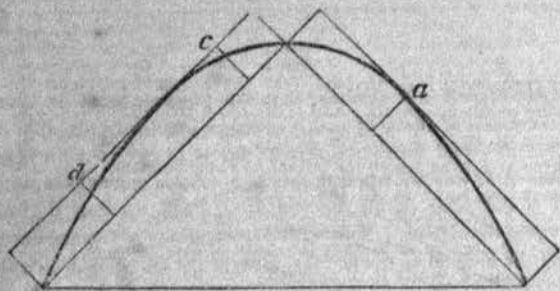


Fig. 3.

Lastly, it being obvious, that these conditions, if correct, must apply to any form of structure whose stability depended on equilibrium; the curve of equal horizontal thrust was ascertained, in a series of rectangular pieces, as in fig. 3, and it was found, that when they were placed inclined to each other at an angle of 45° , the thickness must be $\cdot 1464$ of the length to contain the curve, and that the point of contact was $\cdot 3535$ of the length, from the upper extremity; also, that whether the inclination was greater or less than 45° , the curve fell within the thickness. Then taking two rectangular

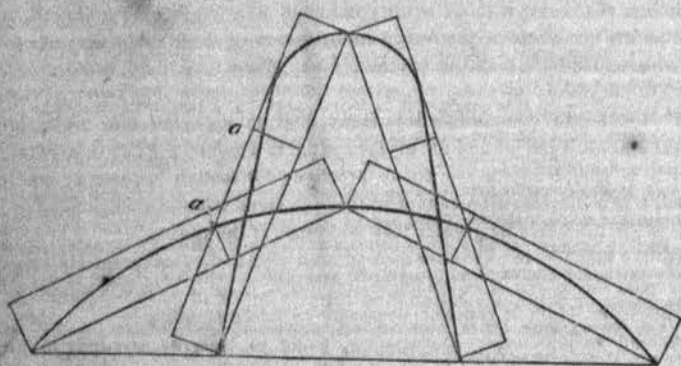


Fig. 4.

pieces of wood of this form, and dividing them where the curve touches the extradosal line at *a*, they will yield by the apex going upwards, when placed at 45° ; but when the angle of inclination is made greater or less than 45° as in fig. 4, stability is obtained; and at the inclination of 45° , if the divisions be made at *c* and *d*, instead of at *a*, fig. 2, although composed of a greater number of pieces, stability is also obtained.

Before leaving this part of the subject, it may not be out of place to mention another experiment, which exhibits the analogy between the catenary and the curve of horizontal thrust.—On a vertical plane surface, an inverted semicircular arch was drawn, and divided into eighteen voussoirs of equal dimensions. Through the centre of gravity of each voussoir, a vertical line was drawn, as in fig. 5. From two pins, fixed at *p* and *p'*, a strong fine silk cord was hung, and eighteen pieces of chain, of equal weight, were attached to it, representing the equal weights of the voussoirs. This species of catenary was then adjusted, so that each of the chains hung opposite the vertical lines, and the apex fell just within the thickness of the arch as shown on the figure. The similarity of the curve thus produced, to that of the curve of equal horizontal thrust, was immediately apparent.

Next, one of the pins at *p* was withdrawn, and the cord was lengthened and attached to another pin at *P*, so as to retain the part *p c p'* in its original position. The line *P p* thus represented the resultant of all the forces acting at *p*, and completing the triangle *P a p*; *a p* the weight or vertical force, was to *P a* the horizontal force as $2\cdot 75$ to 1, which result was found to accord perfectly with that exhibited in a brick arch which was subse-

quently turned, in order to ascertain, by actual experiment, the ratio of the thrust to the weight, in a semicircular arch.

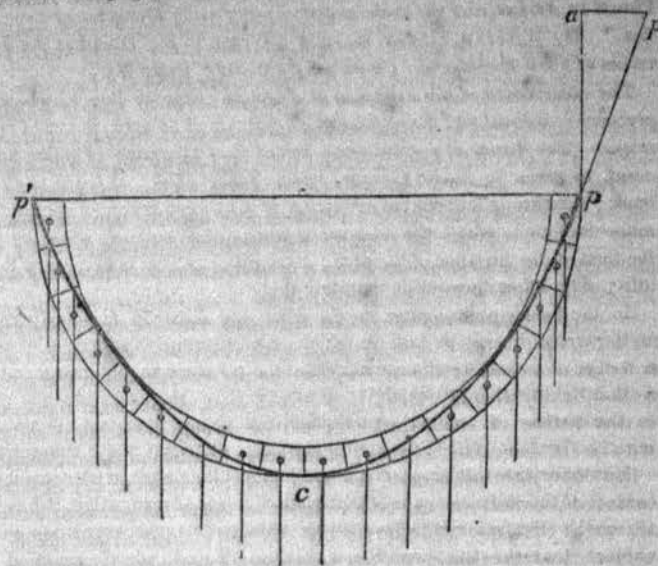


Fig. 5.

Having now, it is presumed, given sufficient practical evidence of the existence of the line of equal horizontal thrust, it only remains to notice, in this part of the subject, that as well as the position of the point of rupture being denoted by it, the direction in which yielding will take place, may also be known. That is to say, it will be outwards, when the curve of equal horizontal thrust touches the intrados, and inwards when it touches the extrados, and before actual rupture, the approach of the curve to either extremity of the voussoirs, indicates the tendency to yield.

Numerous other experiments, of which it is unnecessary to give the details, have shown, that the conditions of equilibrium are the same for the arch and the abutment as for the arch itself; in fact, that the arch and the abutment, when together, may be considered as an arch.

"On the Geometrical Construction of the Curve of equal Horizontal Thrust."

The two half arches being assumed to be symmetrical, the apex of the curve will be in a vertical line equidistant from the springings, and for the present purpose, it will be sufficient to assume one of the two points (supposed to be given), to be in this line. The construction of the curve then resolves itself into two problems.

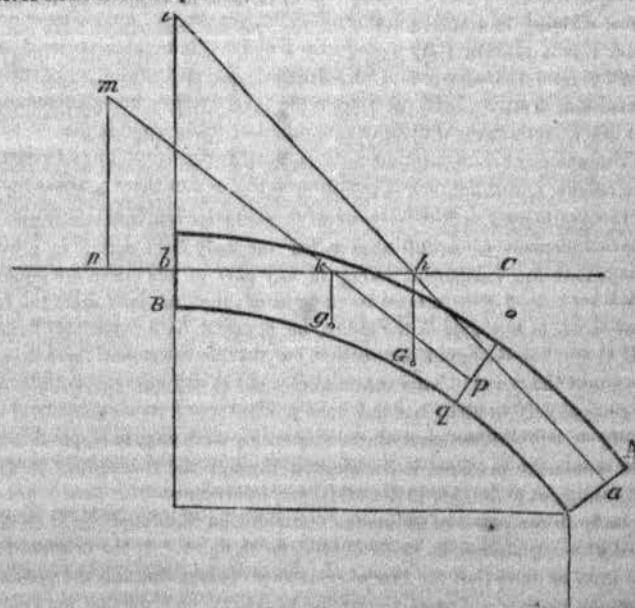
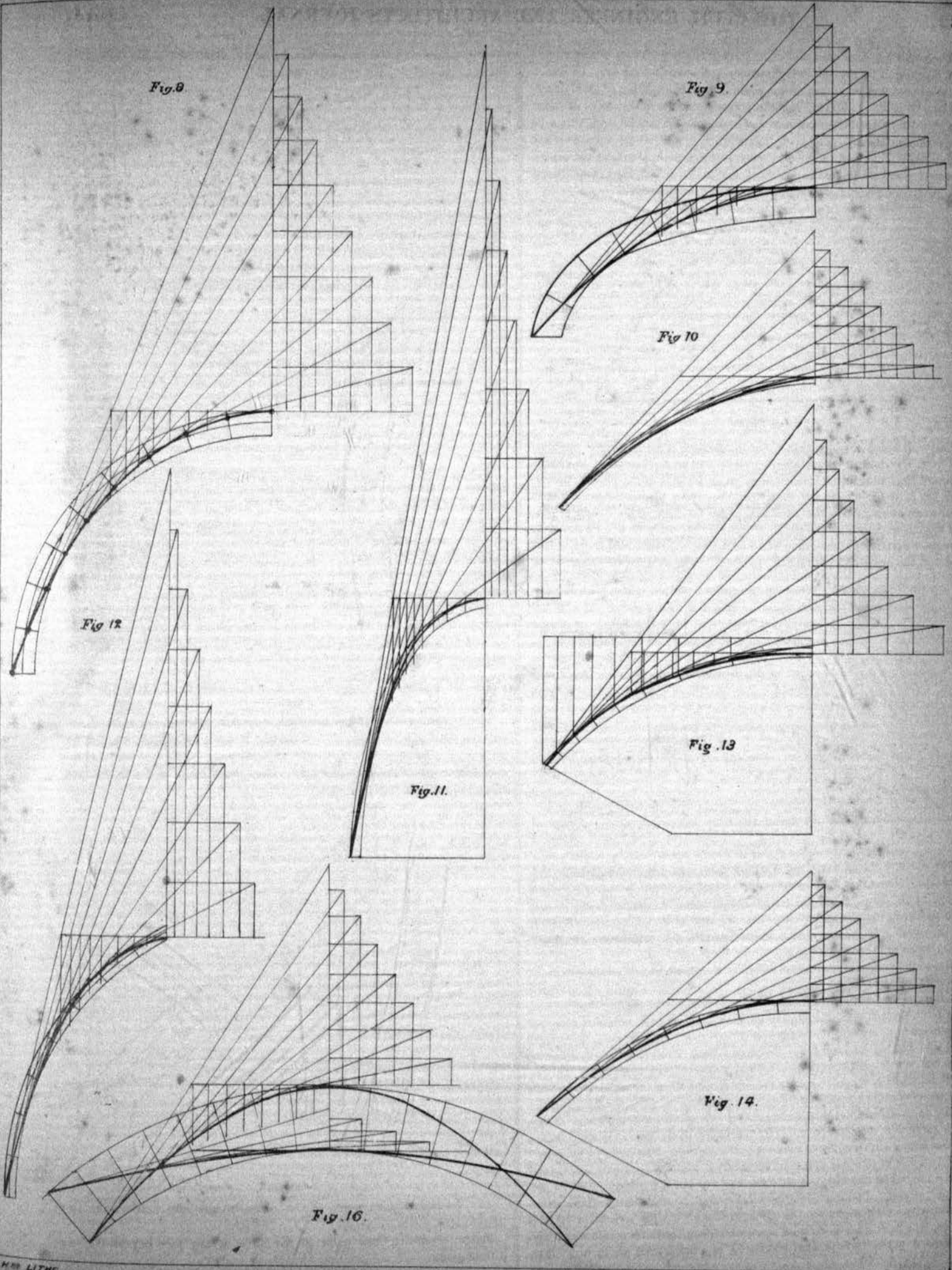


Fig. 6.

- 1st. To find a third point in the curve, at any joint between the two points given.
- 2ndly. To find a third point in the curve, at any joint beyond the two points given.



The first of these constructions, is that which is more particularly applicable, in determining whether a given form of arch contains the curve; for by taking each joint separately, the whole curve is obtained. The second is that which is employed, in determining whether a given abutment is of sufficient thickness to contain the curve.

PROBLEM I.—Let a and b , fig. 6, be two points in the curve of equal horizontal thrust in the arch AB ; required to find the point at which the curve intersects the joint oq . Let G be the centre of gravity of the half arch AB , and g that of the portion oqB . Through b draw the horizontal line cn , and the vertical line bl ; also through G and g , draw the vertical lines Gh and gk , intersecting cn in h and k ; join ah , and produce it to l ; from k set off kn , equal to hb , and through n draw the vertical line nm , making nm to lb as the weight of the portion oqB , is to the weight of the half arch AB ; join mk and produce it until it intersects oq ; p , the point of intersection, will be the point required.

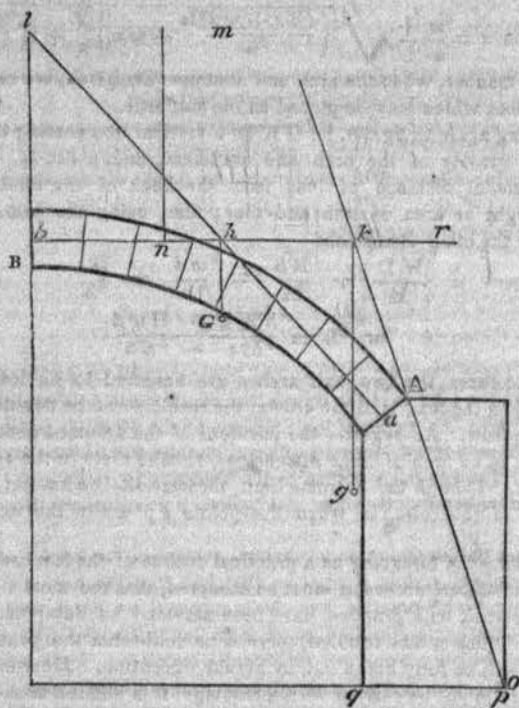


Fig. 7.

PROBLEM II.—Let a and b , fig. 7, be two points in the curve of equal horizontal thrust, in the arch AB ; required to find the point at which the curve intersects the joint oq , being the base of the abutment. Let G be the centre of gravity for the half arch AB , and g that of the arch and abutment taken together. Through b , draw the horizontal line br , and the vertical line bl ; also through G and g , draw the vertical lines Gh and gk , intersecting br in h and k ; join ah and produce it to l , from k set off kn equal to hb , and through n draw the vertical line nm , making nm to lb as the weight of the arch and abutment is to the weight of the arch AB ; join mk , and produce it, until it intersects oq ; p , the point of intersection, will be the point required.

It is unnecessary to accompany these constructions with a demonstration, as it is evident, from the nature of the construction in either case, that the horizontal thrust of the portion AB , at the points a and b , is equal to that of oqB , at the points p and b .—For a loaded arch the construction remains the same; the centre of gravity of the arch and load being taken, instead of that of the arch only.

These constructions point out, not only the form of the curve of equal horizontal thrust in any given arch, but also the direction and amount of pressure at any joint. For as the perpendiculars of the several triangles represent the weights of the several parts, so the hypotenuse of the several triangles represent the resultant pressures at any joint. From this it appears, that the actual pressure, tending to crush the material of which the arch is made, decreases towards the crown of the arch.

Figs. 8, 9, 10, 11, and 12 (Plate XI.), are drawings to scale, of ordinary forms of arches, showing the minimum thickness that will contain the curve of equal horizontal thrust, and that this is the least thickness capable of standing practically, may be readily tested by models; due allowance being made, on account of the joints not being able to be worked

with mathematical exactness. From these diagrams it appears, that the arches which differ most in form from their curves of equal horizontal thrust, are semicircles and semi-ellipses, and that in these forms, there is a tendency for the crown to descend, and the haunches to go outwards. Hence the utility and the general adoption of solid backing and spandril walls in these forms of arches. The pointed arch has a tendency to go up in the crown.

Figs. 13 and 14 show the variations produced in the curve of horizontal thrust, by the addition of the filling in, up to the level of the roadway.

Hitherto, only one line, or curve of equal horizontal thrust, has been spoken of; but if the thickness of an arch be more than sufficient to contain this curve, it is obvious, from the nature of the construction, that more than one such curve will be contained in it, and if the theory advanced is correct, the arch ought to be capable of being supported in any one of these curves.

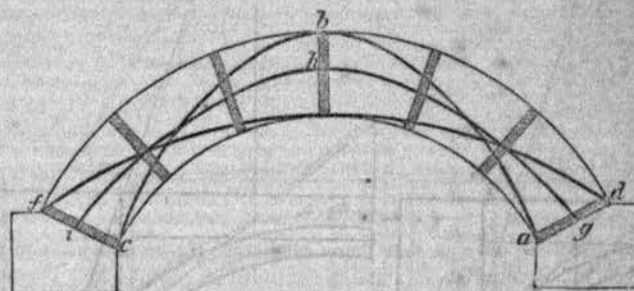


Fig. 15.

The truth of this position was practically tested by the model represented in fig. 15, which consisted of an arch composed of six voussoirs, separated at each joint by four small pieces of wood, each of which could be withdrawn by hand. A curve of equal horizontal thrust was then carefully drawn upon the profile of the arch, as represented in the figure by the line abc , and it was found that, provided the separating pieces were left in at the points where this curved line intersected the surfaces of the voussoirs, the whole of the remaining pieces might be removed, without producing rupture of the arch; in the same manner it could be supported in the curves df or ghi , or in any curve of equal horizontal thrust, which was contained within the depth of the voussoirs; but that if the separating pieces were so placed, that a curve of equal horizontal thrust could not pass through every one of them, the stability of the arch could not be maintained. Of these curves there are two limits, namely, that in which the ratio of the versed sine to the chord at the springing is the greatest, and that in which it is the least. These two curves are represented in fig. 16 (Plate XI.), and are both determinable by the same process.

The first points out the curve, in which the pressure is transmitted through the voussoirs to the abutment, and is identical with that called by Moseley, "the line of resistance."

The other points out the curve, in which a pressure from without would be transmitted from the springing through the arch; such as would arise from the thrust of a second arch. This line may be called, for the sake of distinction, "the line of impression." The one curve, in short, is derived or generated by the pressure the arch exerts; the other that which it is capable of resisting. In different forms and constructions of arches, the amounts of these forces vary very greatly, and it becomes a consideration of importance, where arches of different sizes are abutted against each other.

In the flat arch, fig. 17, the line of impression is a straight line, and



Fig. 17.

therefore, equilibrium could not be destroyed by outward horizontal pressure, until the material yielded by crushing; while by increasing the depth of the voussoirs, the thrust exerted on the abutments may be diminished and rendered comparatively small.

From this, a knowledge of a property in arches is arrived at, which

though felt, and to a certain degree acted upon, has not hitherto admitted of a clear explanation.*

The annexed diagrams, figs. 18 and 19, exhibit forms of arches, supposed to be loaded with a material of equal weight with the arch, and show the abutments necessary to sustain them. In these, it will be observed that

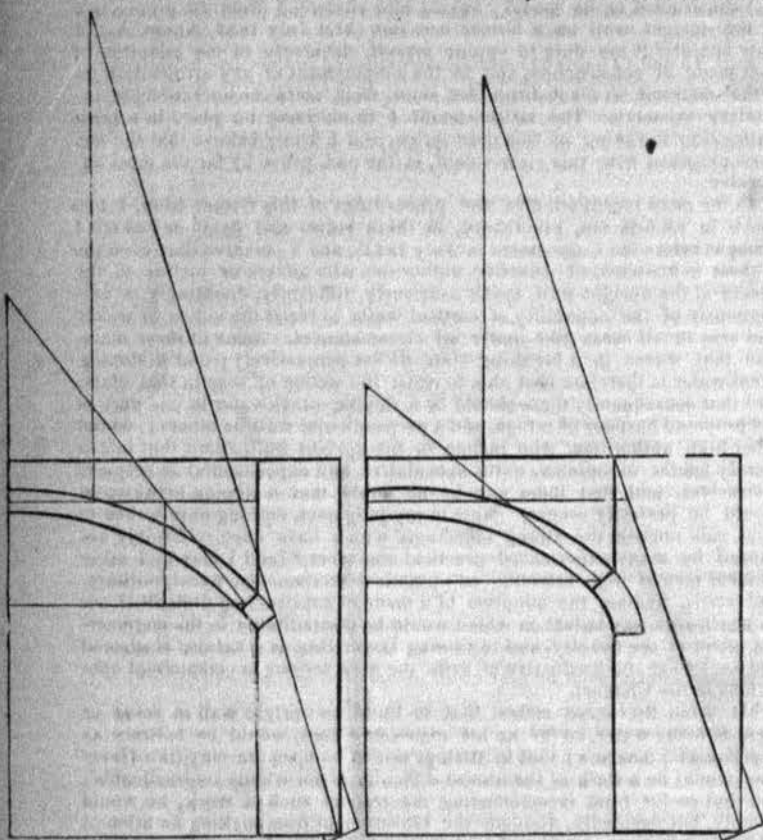


Fig. 18.

Fig. 19.

the division between the arch and the abutment is not made where the arch, so called, commences. The point of division adopted, has not been chosen on account of the result as to the required thickness of abutment being materially affected by it; but as being the place at which rupture would ensue, if the abutments yielded. In fact, the effective part of an arch is only so much of it as would not stand unless the arch were entire. So much of the arch as lies below this point, would stand of itself, and is practically a part of the pier or abutment, curved out for the arch to spring from. This point of division also permits a readier means of computing the thickness of abutments; as with the exception of the small projection at the springing, the weight of which may be omitted, the abutment is a rectangle, when the roadway is horizontal.

In this manner the following formula is derived, for ascertaining the thickness of the abutments necessary to support a given arch; the height of the abutment being given.

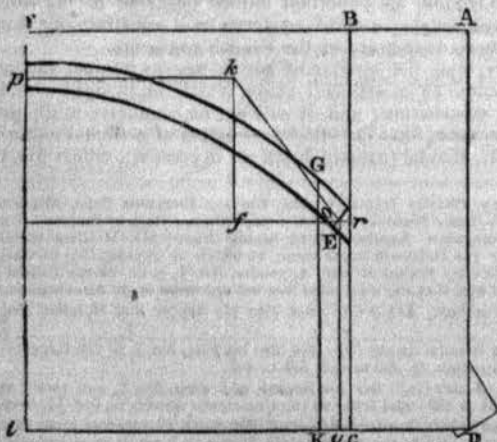


Fig. 20.

If B E F (fig. 20) represent the half arch with its backing, and G is the

centre of gravity—assuming p and p' to be two points of application of the pressure, or points in the curve of equal horizontal thrust in the arch—let $p f = d$, $k f = h$, $p q = m$, $p r = n$, $A D = a$, w = weight or area of arch and backing, and $x = D C$ the width of abutment sought; then assuming equal areas to produce equal weights, $a x$ will be the weight of the abutment; and when x is such, that the curve of equal horizontal thrust will meet the base of the abutment at the extreme point D, we have

$$\frac{a x^2}{2 m} + \frac{w (x + n)}{m} = \frac{w d}{h},$$

$$\text{or } x = \frac{w}{a} \pm \sqrt{\left(\frac{d m}{h} - n\right) \frac{2 w}{a} + \left(\frac{w}{a}\right)^2}$$

Also to find the thickness of abutment when any given additional load is placed on the arch, let B be the load, expressed in terms of the area of the arch and backing, and s its horizontal distance from the point p ;

$$\text{then } x = \frac{w}{a} \pm \sqrt{\left\{\frac{(B s + w d) m}{h} - w n\right\} \frac{2}{a} + \left(\frac{w}{a}\right)^2}$$

In like manner, when the arch and abutment are given, we can find the extreme load which may be placed on the half arch.

Referring again to fig. 20, let $G K$ be a vertical line passing through the centre of gravity of the arch and abutment, and $p' l = H$, $D K = D$, S = horizontal distance of load from the back of the abutment, and W = weight or area of arch and pier; then using the same letters as before for the other dimensions—

$$\frac{W D}{H} + \frac{B S}{H} = \frac{w d}{h} + \frac{B s}{h}$$

$$\text{or } B = \frac{h W D - H w d}{H s - h S}$$

In these cases, the two half arches are assumed to be loaded alike; hence, when the load is at the crown, the result must be doubled, to give the entire load. As regards the positions of the assumed points $p p'$, it is sufficient, in an arch of large dimensions, to take them in the centre of the thickness. Though the extreme limit, theoretically, in an arch turned in one ring of voussoirs, is when the points $p p'$ are in the line of resistance.

In offering the foregoing as a practical outline of the laws which govern the equilibrium of arches, it must be observed, that the most simple conditions consistent with practice, have been assumed as data, and so far as these conditions can be fulfilled, there is no doubt that the principles here set forth will be fully borne out in actual execution. How much further the inquiry might be carried with advantage, it is difficult to say: but there appears to be much connected with the unequal loading of arches, which has not hitherto been the subject of investigation.

Moseley has introduced in his researches, the effect of the adhesion of cements; but he has accompanied it with the remark, that "that structure (being of large dimensions) which would not stand without cement, would assuredly be a perilous one," a remark which applies very properly to arches of masonry; but in brick arches, turned in numerous rings, the adhesion of the cement undoubtedly becomes an element, materially affecting the stability of the structure. Upon such subjects, and upon the varying conditions in which arches are placed, it is in vain to attempt to bring theory to bear. They are considerations which must and ought, at all times, to be left to the skill and judgment of the engineer.

In practice, an arch will exert more pressure and resist less than theory would denote; because the conditions of unyielding materials and mathematical adjustment of the joints, are incompatible with practice. Even in arches of the hardest stone, and with the best workmanship, the lines of resistance and impression must not be brought too near the extremities of the voussoirs; and in brick arches, particularly those turned in separate rings, a much greater latitude must be allowed. It must be evident, however, that it is desirable to form brick arches as much as possible in one bonded mass, using the best cement.

In abutments, a still greater variety of considerations will arise. To render this part of the subject tangible by theory, the abutment must be assumed as standing alone, the foundations being perfect, and the point of rupture being at the base of the abutment. In practice, they are rarely, if ever, without earth behind them, aiding more or less in their support. Some cases, such as in arches under embankments, the force acting to push in the abutment, exceeds the horizontal thrust of the arch, and a tendency has been frequently exhibited in arches so situated, to rise in the crown.

The foundations, the wing walls, the spandril walls, the backing, the nature of the materials employed, and many other practical considerations,

all tend to affect the stability, and modify the results of theory; each of which circumstances, acting pro or con, will be made to fulfil its duty to the best advantage, by the skilful engineer. The utmost that theory can do, is to show the conditions of equilibrium, under certain fixed practical data, and there can be no doubt, that the line of equal horizontal thrust in an arch, is analogous to a vertical line drawn through the centre of gravity in a column. That this line should fall within the mass at every joint, and that the position of each joint should be such, that the direction in which the pressure acts should be within the limiting angle of friction, are conditions common to both structures.

[The interesting observations made at the meeting of the Institution, by the members, after the reading of the paper, will be given in the next month's Journal.]

CONSTRUCTION OF SEA WALLS.

A Protest against the Decision of the Members of the Harbour of Refuge Commission present at the Sitting of the 13th January 1846; and Dissent from their Report, on the part of Lieutenant-General Sir HOWARD DOUGLAS, one of the Commission—presented to the House of Commons. (Slightly abridged.) The annexes referred to will be given in the next month's Journal.

Attaching the greatest importance to the attainment of certainty in the mode of forming, and of durability in that of executing the extensive works about to be undertaken for the proposed harbour of refuge in Dover Bay, I consider it incumbent upon me to express my marked opinion, in opposition to plans which, in my judgment, are founded on modes of construction not resting upon any proved principle, and untried upon any sufficient scale to warrant their present adoption; which are moreover theoretical in conception, and consequently uncertain in their ultimate result. Such plans are, in my opinion, unfit for the attainment of the great national object which we have in view; and which it is my most anxious wish to see undertaken in such a manner as will leave no doubt of its being successfully accomplished.

Considering, then, that the building of an upright wall in the open sea, in seven or eight fathoms water, is a proposition novel in theory, and never, in so far as I am aware, proved in practice, on a scale to warrant its adoption;¹ and being of opinion that a breakwater of the proposed elevation and magnitude, rising with an upright face, from the depth of 42 feet at low water, would be far less capable of resisting the violence of seas,² and

¹ See Observation on Kilrush Pier, built in only 9 feet 6 inches depth of water.
² The application of the theory of the resistance and impact of fluids is no doubt attended with great difficulties and anomalies in this as in many other cases connected with natural philosophy; but whatever results have been derived, either from theory or observation, they all agree in this, that the horizontal impulse of a fluid on any resisting body is increased, in a very high ratio, as the inclination of its surface (A B) to the direction (B C) of the motion increases. The fundamental theorem is, that this varies as $(\sin \theta)^2$ (θ representing the inclination), because the height of the breakwater continuing the same, the quantity of fluid impinging on it will be the same at all inclinations. If the height of the breakwater were variable, the whole impetus would then be as $(\sin \theta)^3$.

because in this case, not only is the force of each particle diminished in proportion to $(\sin \theta)^2$, but the number of particles which impinge on the plane varies as $\sin \theta$.

From this resolution of the pressure of a fluid against the surface of a body, whether either be in motion and the other at rest, or both body and fluid be in motion, some of the most useful results of practical science are obtained. By this a ship is impelled forward obliquely to the direction of the wind, even when that direction is before "the beam;" and a like resolution of pressure gives rise to the propulsive force of the revolving screw, or enables the rudder to retain and guide the vessel in her intended course. The oblique action of the water on the side of the vessel or raft, permits a "flying bridge" to be sheered across a river; and not only does that of the wind give motion to the sails of a mill, but by a proper variation of the obliquity of these, according to the distance from the axis of motion, the impelling force is rendered equally on every part.

In the application of this principle to practical mechanics, great difficulties certainly occur from our imperfect knowledge of the manner in which the forces of nature are exerted; and the problem concerning the action of the sea against a wall, can no more be solved by the resolution of forces than the trajectory of a shot, in a resisting medium, can be determined by the parabolic theory, or even by any theory founded on the usually assumed law of resistance; yet such a theory has its uses for the practical artillery; and a knowledge of the mathematical principles of hydrodynamics is essential to an adequate conception of the means to be employed for resisting the actions of waves.

On the best form for the profile for a "breakwater" a difference of opinion exists; and while, on one hand, it is contended that the exterior face of the wall should be vertical, on the other, a face inclined to the horizon is recommended. The advocates of the former construction seem to consider that such a wall is subject only to the hydrostatical pressure of a fluid at rest, or that the agitations of the water before it, takes place only in vertical directions; but neither of these conditions holds good in Dover Bay, or wherever by the force of winds and currents the waves are impelled with violence against the shore. That loose stones constituting a breakwater, when deposited so as to form an inclined plane, should be occasionally displaced by the action of waves is sufficiently obvious; but that, with equal quantities of material, a vertical wall should resist the concussions produced by such action, as efficaciously as one with an exterior slope, is inconceivable.

It does not follow, however, that the face of a breakwater should have one uniform slope from the bottom upwards; the part lashed by the waves in an open sea requires a longer slope, or a smaller inclination to a horizontal plane, than the part below; and this deduction from scientific principles by many eminent authorities is confirmed by the practice of engineers.

especially of broken seas, (exposed as it must, moreover, be to the unremitting action of strong tides and currents) than a sloping breakwater formed in a manner similar to that which has been successfully completed in Plymouth Sound (which is now in a state of perfect repose and stability) (Annex B. D.), as well as similar to others (Delaware Breakwater, Annex L.) constructed on its model; having also dissented from the proposition of the upright wall on a former occasion (31st July 1844, Annex A.), I now consider it my duty to oppose myself, decidedly, to the adoption of that mode of construction, and to the employment of any artificial or inferior material, as a substitute for stone, from mere considerations of pecuniary economy. The latter should I think have no place in a great national undertaking of this description, and I firmly believe that the method proposed with this view would, in the end, prove by far the most expensive.

In the more recent minutes and proceedings of this Commission, I find much to confirm me, practically, in these views and opinions (which I brought before the Commission in July 1844), and I perceive that even the highest acknowledged scientific authorities who adhere or incline to the theory of the upright wall, speak cautiously, diffidently, doubtingly, or ambiguously of the capability of vertical walls to resist the action of waves and seas in all cases and under all circumstances. Some of these maintain that waves in a breaking state do act percussively; that a sloping breakwater is therefore best able to resist the action of seas in that state, and that consequently there should be a sloping breakwater in one part of the proposed harbour of refuge, and a perpendicular wall in others; whilst other high authorities, who incline to the upright wall, admit that this is merely matter of opinion, quite speculative and experimental as respects themselves, and that there can be no doubt that a sloping breakwater would be perfectly secure. Now in my judgment, nothing purely theoretical can remove the strong objections which have been so forcibly advanced by many experienced practical engineers,³ (and I may add other eminent men of high scientific and practical attainments, naval, military, and civil), against the adoption of a mode of construction difficult if not impracticable, any failure in which would be discredit to the engineering talent of the country, and in ruining Dover Bay as a natural roadstead and anchorage, be productive of evils the most serious to commercial operations in the Channel.

Mr. Alan Stevenson states, that to build an upright wall in seven or eight fathoms water, so far as his experience goes, would be entirely an experimental measure; that to attempt this in an open sea-way like Dover Bay, would be a work of the utmost difficulty, if not wholly impracticable; and that so far from recommending the trial of such a work, he would humbly, but decidedly, dissuade the Government from making an attempt which he was sure would end in failure; and, in reply to cross-questions put to him with a view to shake his testimony against the upright wall, he denies the theory on which that mode of construction is founded. He asserts, on his own experience, that waves are not purely oscillatory, but have onward motion, and consequently percussive force, such, in his conviction, that any attempt to check their force by means of a vertical wall, will prove a signal failure; for that a force would be developed by the collision of the wave with the wall, whose amount will be found to surpass any which has ever been experienced on the face of a sloping breakwater.

In the course of the protracted discussions to which my opposition gave rise, the danger was demonstrated of using, in such a work, a material (concrete) to which I had always objected, as deficient in tenacity, and incapable of resisting mechanical action of water. An opinion of the efficiency of this material was, however, strongly supported by the reference made in an official report, and in a leading question to the use of blocks of concrete for the completion of the breakwater in Cherbourg Bay, which was described as a successful experiment, and one deserving of being adopted by us, as a precedent; but the contrary of both was soon evident; for within the period to which, happily, the proceedings of the Commission were thus extended, an important failure occurred in the works at that place; and the employment of concrete, as a substitute for stone in this climate, has been abandoned by the French engineers.

This failure, and the opinion of Sir R. Smirke against the adoption of blocks of concrete as an artificial stone, which he thought would fail, disposed of this proposition; and it will not be conducive to the public interests, in my opinion, that the other description of artificial material recommended by Mr. Rendel (namely, brick set in cement), which Mr. Corderoy

Poisson, Prony, Charles Dupin, Girard, Cachin: Professor Cape, Military Seminary, Addiscombe; Professor Narrien, Royal Military College; General Bernard, United States' Engineers; Commodore Rogers, United States' Navy; Mr. William Strickland. See Annex. (L.), on the Delaware Breakwater, by which it appears that Colonel Jones was misinformed.—See his Report of 1846, Appendix, No. 1, p. 72, by the United States' Engineer, who told him that the long slope was not approved of by American engineers.

³ 1. Sir John Rennie, Annex (B.) See also his Report and Opinion, No. 4, of plans sent in.

2. Mr. George Rennie, Annex (C.) See also his plan, No. 2, of the Reports; his model and recent examination, Q. 430 to 434, 445 to 447.

3. Mr. Cubitt, Annex (D.) See his Report and plan, No. 6, and recent examination, Q. 210 to 213, 234 to 238; and letter to the Chairman, Appendix, No. 11, Second Report.

4. Mr. William Stuart, superintendent of Plymouth Breakwater, from the commencement of the work in 1811 to the present time, Annex (F.), evidence of June 20, 1844.

An important evidence, showing that the damages which that work had sustained arose from the slope or foreshore not being long enough; stating his practical objections to a more upright slope, and his conviction that it could not stand; and that, if that breakwater had been constructed upright from the bottom of the sea, it would have been incapable of resisting the force of the waves.

contractor, states, would cost twice as much as concrete, and which Mr. Smirke says would be more expensive than stone, should be used.

With respect to the adoption of blocks of concrete;—far “from standing remarkably well in the breakwater at Algiers,” the whole mass of the breakwater has settled bodily, not from the effects of gales of wind, but from defects in the material (which time will further show); this, there is no doubt, is occasioned by the chemical action of the sea, “which in the Mediterranean contains 7·02 per cent. of sulphate of magnesia, whereas the water in the ocean contains only 2·29 per cent., consequently, of two moles made of the same concrete, the one in the ocean may last an indefinite period, the other will dissolve in a few years; and even mixing puzzolano with the concrete will not guarantee the lime from solution.” Nor can that work, under any circumstances, be cited as an example for our imitation on the coasts of Great Britain. There are no tides in the Mediterranean, and the climate there is well suited to the drying and consolidation of that material, which is not the case in more northern regions.

It may be added, that the form of the work at Algiers is not that of an upright wall, for its face has a slope of 45 degrees; the work, therefore, cannot be adduced as an example in favour of that form of construction.

In support of my dissent from the adoption of the upright wall, I appeal to the debate which took place at the Institution of Civil Engineers, in April 1842,* on Colonel Jones’s “Observations upon the Sections of Breakwaters as heretofore constructed, with Suggestions as to some modifications of their Forms.” This debate may be taken as a very fair exposition of the opinions of practical engineers on the principle of the upright wall.

The president, Mr. Walker, took an important part in that discussion. He said, “It is evident that if the materials are deposited at an inclination, any portion being displaced, is only carried down elsewhere. Although strictly speaking it may not be wanted, it must nevertheless assist in consolidating the mass, and the vacant spaces can easily be filled up. Under similar circumstances (to those which displaced some of the stones in Plymouth Breakwater) a perpendicular wall would suffer more severely, and probably would have fallen entirely. He therefore considered that in situations like that of the Plymouth Breakwater, which was exposed to a heavier sea than Cherbourg, a long slope for the sea face was essential.”

Mr. Palmer, vice-president, observed that the form suggested by Colonel Jones for the faces of breakwaters, did not appear sufficiently justified by observed facts; that the idea was entirely of a speculative character, and was contrary to the laws of nature, which should be the engineer’s chief guide; and he attributed the failure alluded to by Colonel Jones, in the harbours of Ardglass, Portrush, &c., more to defects in workmanship, than to faults in the principle of the structure.

General Pasley said he conceived that a perpendicular wall, constructed of large ashlar work, well cemented, would assume the character of a rock, and all the prejudicial action of the receding wave would be avoided.

Mr. Bull differed entirely from Colonel Jones’s opinion as to breakwaters with vertical or nearly vertical faces, because any disturbance of the footing, however slight, must have a tendency to overthrow the wall.

Mr. George Rennie deprecated in strong terms the upright wall, and stated that the late Mr. Thomas Telford had abandoned that mode of construction.

Mr. Vignoles only agreed to a certain extent, to the form proposed by Colonel Jones, and recommended a combination of a slope below with a vertical parapet above.

Mr. Gordon was in favour of the slope; and stated that a sloping breakwater, composed of *pierre perdue*, with a sloping face, had withstood undisturbed the surf at Madras.

Mr. McNeill adduced the long slopes of sand, at an inclination of 10 to 1, thatched with straw, which resist the waves of the ocean on the coast of Holland.

Thus we have in this discussion, a majority of speakers of seven to two, in favour of the slope; and of the minority, one was for a combination of the slope with a vertical wall above. Even Colonel Jones suggested this modification. See page 125, vol. 2, Proceedings of Institution of Civil Engineers. Plan No. 5, proposed by him for Dover Bay, was of this description.

I object to Kilrush Pier being adduced as a test of the principle of the upright wall sufficient to warrant its adoption in the construction of a harbour of Refuge in Dover Bay. Kilrush is a small tidal harbour on the coast of Ireland for coasting vessels. The piers are built in only 9 ft. 6 in. depth of water, at low tide. The foundations were laid without difficulty by the diving-bell, with large masses of stone, which were easily and quickly deposited. The area of the section of the wall is considerably greater than that of the old work; but so far from the upright wall having been built in consequence of the sloping profile as originally proposed having failed, Col. Jones expressly says “that the old work stood remarkably well.” There is nothing in this, therefore, either practically condemnatory of the slope, or sufficient to warrant the adoption of the upright face, on such a scale as to which these proceedings relate. There is no doubt, as Mr. Palmer says, the piers of the small harbours which Captain Washington reports to have been so much damaged by the sea, were constructed in a very defective manner, and with materials of dimensions that ought not to have been put in, and it likewise appears that the damage which these piers may have sustained might easily be repaired; but certainly no such errors would be committed in any new work of this description, far less in that great national work now under consideration.

* Proceedings of the Institution of Civil Engineers. See Journal, vol. 5, 1842, p. 318.

The recommendation of a majority of the Commission in favour of the upright wall is stated, in the Report, to have been made on a summary.

1. Of the conflicting opinions entertained by the eight engineers whose plans for constructing a harbour of refuge in Dover Bay were submitted to the Commission; and

2. With reference to the opinions of those persons who had been requested to give their evidence or advice upon this important question.

The following is a list of the engineers whose plans for constructing a harbour of refuge in Dover Bay were sent in to the Commission:

1. James Walker; 2. George Rennie; 3. Captain Denison; 4. Sir John Rennie; 5. Lt.-Col. Jones; 6. W. Cubitt; 7. Charles Vignoles; 8. J. M. Rendel.

1. Mr. Walker, civil engineer, is somewhat inconsistently adduced in the Report as an advocate, in principle, for the construction of a nearly upright wall. The project submitted by Mr. Walker to the Commission, is to build these walls in immense vessels, or as he calls them, “utensils” (caissons), three or four hundred feet long and seventy feet wide, containing two or three thousand tons of ready-made breakwaters, to be towed by steam tugs and stranded in Dover Bay! But we have Mr. Walker’s authority, from what he said at the meeting of the Institution of Civil Engineers, on April 12, 1842, that his reason for proposing nearly upright walls in this case, was to avoid the extravagant width which must be given to these huge utensils, if the walls have any considerable slope; for, at the discussion to which I refer, Mr. Walker stated, that in situations exposed, like that of the Plymouth Breakwater, to a heavier sea than that which rolls into Cherbourg Bay, a long slope for the sea face was essential; and that had a perpendicular wall been constructed in Plymouth Sound, instead of a sloping breakwater, it would, in the storms which assailed it, have suffered more severely than it did, and probably would have been entirely overthrown.

The dangerous instability of works executed in deep water, by a system of caissoning, such as that proposed by Mr. Walker, is very generally acknowledged, and is sufficiently proved by the perilous state in which Westminster Bridge now remains, notwithstanding the costly expedients by which it has been attempted to remedy the defects of its original construction. These expedients consist in forming a cofferdam about each pier, pumping out the water, and then driving rows of sheet piling into the blue clay, so as to form a girdle round the base of the original caisson, and thus to prevent the materials of the natural bed of the river from being underwashed by the current, or squeezed out by the weight of the bridge, into the gradually deepening water-courses. But it does seem very strange, that these expedients having failed to arrest the subsidence which is still taking place in Westminster Bridge, the method employed in the construction of that work should be proposed for adoption, on an immense scale, in the formation of a harbour of refuge in Dover Bay.

2. Mr. George Rennie deprecates the upright wall as impracticable and dangerous, and strongly recommends a sloping breakwater, as at Plymouth.

3. Captain Denison is for a vertical wall formed of hexagonal prisms of concrete (proposed by Monsieur Emy, in 1831, but never adopted), 10 feet long, and about 23 tons weight, to be manufactured at Dungeness, and dragged by steam tugs to Dover Bay, by being suspended to rafts formed of two cylindrical pontoons, and there sunk by mechanical means. The wall to be upright from the bottom to about low-water mark, with a superstructure of granite.

4. Sir John Rennie, after deprecating in strong terms all systems of caissoning, and some other expedients, particularly the adoption of upright walls; and after urging the disastrous consequences that may attend any mode of construction which is not recognised as certain of success, proposes the adoption of the principle observed in the breakwater at Plymouth. This he considers as having completely succeeded, and therefore he conceives that it fully justifies the adoption of the like mode of construction for the proposed harbour of refuge in Dover Bay.

5. Colonel Jones is in favour of a combination, of a sloping breakwater, up to low-water mark, with an upright wall of stone erected on it.

6. Mr. Cubitt, after having been a little taken with the theory of the upright wall, and having since bestowed upon this subject the most careful consideration, comes to the conclusion that any attempt to erect an upright wall in Dover Bay would be an undertaking of great difficulty, and that the only safe and practicable mode of execution is by depositing masses of stone, to form a sloping breakwater, as at Plymouth, with stone brought from the Channel Islands, or from Portland.

7. Mr. Vignole’s plan is to form a sloping breakwater, by depositing cubical blocks of concrete up to about low-water mark, and upon this to erect a vertical wall.

8. Mr. Rendel is next adduced as an advocate for the upright wall. Now, with great respect for the practical opinion of this eminent engineer, it is of importance to review in detail his several examinations before the Harbour of Refuge Commission, previous to his conversion to, or adoption of, the new theory, and to advert to the circumstances with respect to material, which induce him now to recommend a wall of that form.

In his examination of the 19th of June 1844, Mr. Rendel told us, that to construct a breakwater in seven fathoms water is a very formidable undertaking, especially if caissons or other machines should be resorted to; and that he doubted very much whether if a breakwater is to be constructed in seven fathoms water, the only safe plan would not be, to deposit stones in the usual way from vessels; bringing up the mass to within,

say two or three feet of low water; above that, he proposed to construct perpendicular walls, as recommended by Colonel Jones; observing that if stones were deposited in this manner, and allowed to form their own slope, it would in most situations be the most economical plan.

He stated that if he had an unlimited command of materials, he would first begin to deposit those materials so as to form a rough mass, and when he had brought his foundations up to that point (nearly low-water mark) at which the sea would begin to attack him, he would attack the sea, by building with a class of materials that would be its master; adding, that he thought an upright wall in this case might be desirable for a superstructure.

In Mr. Rendel's examination before the Commission, in November 1845, his attention was expressly called to his former evidence by several questions, to all of which he replied that he retained the opinions expressed in that evidence; and also stated that he did not know of any instance in which a breakwater with an upright face, of the magnitude now contemplated, had been constructed in the open sea in seven fathoms water. He added, that so far it is an experimental measure. Mr. Rendel's reasons for adopting the upright wall, in the project which he now proposes, are founded purely on considerations of economy in money and time. He observed, that where there is abundance of masses of stone, fit for constructing breakwaters, he would form them of rubble stone up to low-water mark, with sloping faces, in the manner in which he had just finished a design of Holyhead harbour; but in order to avoid the expense of bringing stone to Dover, he proposed to adopt, as substitutes for stone, rectangular blocks of brick, set in cement, ten feet long, five wide, and three thick, and with these to build a perfectly upright wall in Dover Bay, by means of powerful machines and the use of the diving-bell. On a former occasion Mr. Rendel objected to the employment of machines, and particularly to the use of the diving-bell. This proposition, therefore, resolves itself into the question, whether such a project would be economical.

Mr. Rendel admits that if the execution of the work by means of brick blocks were pressed on so rapidly as to render it necessary to import into Dover bricks, or materials with which to make them, a great part of the economical advantage would disappear. He also acknowledges "that the advantages of that mode of construction, namely, the upright wall, over the common sloping-sided breakwaters, is a mere question of economy in money and time." He has further admitted, that if he had unlimited command of materials at Dover, he would adopt the usual mode hitherto observed in constructing breakwaters. Now Mr. Hartley expressly states, that the expense of providing brick blocks made of the materials that he recommends as indispensable in the construction of such a work, would be greater than that at which granite might be procured from the Channel Islands.

From this and other calculations it appears, that "the mode of constructing breakwaters hitherto observed," with materials of the best description, is preferable, in an economical sense, to that proposed by Mr. Rendel, and this being so that he would renounce it. We have this reliance on Mr. Rendel's discretion and judgment, that he would guard himself against assuming anything where experience, the only safe guide, can be referred to; and, in a great national work like this, would not propose any new-fangled notions that have nothing but their ingenuity to recommend them.

If then the question, whether the theory of the upright wall, or the established practice of the slope, was to be determined by the opinions of a majority of competitors, the Commission ought to have decided the other way, for, of the eight engineers who gave in plans, four recommended the sloping breakwater; and, of the other four, two propose a combination of the slope below, with a nearly upright superstructure; and only one prefers the upright wall, and this provided his proposition for using brick blocks of 25 tons weight as substitutes for stone, be adopted.

The following is a list of the persons whose opinions are adduced as advising the construction of the upright wall:—1. Professor Airy; 2. Professor Barlow; 3. Major-general Sir J. Burgoyne; 4. Sir Henry De la Beche; 5. Mr. Hartley; 6. Major-general Pasley; 7. Captain Vetch; 8. M. Reibell; 9. Mr. Brunel; 10. Mr. Bremner.

1. Professor Airy's opinion in matters of science is unquestionably entitled to the very highest respect. I have studied with the greatest attention and profit the Astronomer Royal's tract, in which the phenomena of tides and waves are investigated by a refined analysis on what is called the "wave theory." It is assumed that in deep water, the motions of the particles are oscillatory, and that the rising and falling of the surface of the sea depend on the horizontal movements taking place alternately in the same and in contrary directions; that these displacements are represented by a periodical function (the sine or cosine of an angle depending on time). The circular or elliptical movement of the particles is shown to take place only when a wave is transmitted along a channel of uniform breadth and depth; and the fact, that, as the depth of water becomes less, waves become shorter and their fronts steeper, is proved to be in accordance with what may be deduced from the theoretical expressions of the displacements. It follows from this, that, as a sea-wave advances into water gradually becoming shallower, it assumes a crested shape, the upper particles moving towards the coast, till at length the top rolls over the base, the wave breaks, and a surf is created. Reference is made in this article to the special treatises on sea-waves by MM. de la Coudray and Bremontier.

When Mr. Airy was Professor of Natural Philosophy at Cambridge, he

explained, with success, that waves in a fluid at rest, such as we may conceive to arise from throwing a stone into a pond, or the ordinary waves in a close lake, are more or less superficial undulations, and that in reality no current, or onward motion of the fluid, appears to take place. I well remember, also, that he invented an ingenious machine by which he illustrated this oscillatory motion. But admitting this to be true, to a considerable extent, in a pond or a small lake, it is totally inapplicable to the sea, the open sea, in Dover Bay, where an immense body of water is in constant motion, by tides rising and falling fifteen or twenty feet in the course of two or three hours, and where the surface is liable to be acted upon by heavy gales, which drive in rolling seas in succession with rapid onward motion, and therefore producing percussive force in the direction of the wind. Without however entering here on Professor Airy's theory of waves in deep open sea, but confining myself to deductions from that theory, as to the practical effect of waves in gales of wind on erections in the sea, of a limited depth, it will be seen, that instead of his theory (that the upright wall is in all cases preferable to the slope) being absolute, this eminent authority allows that waves in a breaking or broken state do act percussively and powerfully as hydraulic rams, and not by hydrostatic pressure. How then can that hydraulic action cease and become merely hydrostatic pressure unless it has first exerted a force of impact upon the wall which arrests its motion? Even if the wall should stand after having received the shock, the concussion must be more severe on an upright wall, in the ratio above mentioned, than that which would take place on a sloping wall of equal height.

The question of construction, then, resolves itself into this: in what depths of water do waves assume that form and acquire that percussive force? Where, according to this, should the slope cease and the upright wall commence? The professor says, practical opinion, that of the pilots, can best determine this.

Those whom I have questioned on that subject say, that this will be found to take place, in heavy gales of south-west and southerly winds, throughout nearly the whole of Dover Bay at low water.

However this may be, it is clear from the Astronomer Royal's deductions from his own theory, that there should be a sloping breakwater in the shallower parts of the space to be enclosed, and an upright wall in the deeper.

But with respect to the practical question, Professor Airy states, in reply to question 595, whatever theory may say, "that building an upright wall in the open sea, in seven fathoms water, is so far an experimental measure, that no such work has ever been executed."

With every respect, then, for the theoretical opinion of this high authority, I cannot consider that it would justify the Government in sanctioning the mode of construction recommended by a majority of the Commission; it may rather be inferred that this is contrary to the deduction of science, and that, if the difficulties of constructing such a wall in deep water could be overcome, it would be incapable of resisting the action of the sea where waves assume that shape, and possess that percussive power, which Mr. Airy admits.

2. Professor Barlow has most usefully applied mathematical investigation to practical purposes, and knows well the difference between theoretical views and practical effects upon a proposition of this description. In his letter of the 5th January 1846, written in reply to the question referred to him, he states, that theory cannot safely settle that question; he avows that he has not sufficient practical knowledge or experience to enable him to speak confidently on the subject; expresses himself diffidently, cautiously, and even ambiguously, as to theory; and recommends that the question be referred to practical men for their opinion, made upon results obtained from actual experience and observation. The learned professor therefore rather declined and disclaimed giving a decided opinion in favour of the upright wall; and I think he will be surprised to find that his letter has been adduced, by a majority of the Commission, rather as conflicting with, than as deferring to the opinion of practical men. Further it appears, by the professor's letter, that he is decidedly opposed to the theory of the upright wall; for he denies the assumption on which it is based: namely, "that waves have no onward motion." He states, "there can be no doubt that waves when acted upon by tempestuous winds, will beat with great violence against any obstacle opposed to their progress; that what we want in breakwaters is, to resist that force; to withstand that momentum; and that much of this direct violence would be avoided, by receiving that action on an inclined surface."

3. I refer with the greatest deference and respect to any practical opinion of so eminent a man as Major-General Sir John Burgoyne; but I do not read his letter on the comparative merits and capabilities of the upright wall and the slope, as containing any very positive or confident preference of the former; and in that letter it is admitted that there can be no doubt as to the security of the slope. This distinguished military engineer says,

"The effort against the upright wall I conceive would be far less.

"In deep water, the action of the wave is, I apprehend, an up and down undulation, the water having very little, if any, forward motion, except where it breaks. A flat piece of wood, floating on the surface, and presenting no hold to the wind, would progress very slowly before the heaviest gale; therefore I consider that there would be no blow or impulse generally on the upright wall, but merely the weight of water from the top of the wave to its mean level, to be supported.

"I should not expect that the wall itself would cause the waves to break, and even those that accidentally did so at that particular place would have

much of their force caught by the receding of the previous wave, so as rarely to strike with much force against the wall itself.

"There can be no doubt but that a slope could be given to a breakwater that would be very secure.

"In Holland, the shores, even of sand, are in many parts secured against the whole force of the North Sea by a surface coating of mere clay and straw, but then the inclination is exceedingly gentle quite to deep water, not more, I apprehend, than 1 in 18 or 1 in 24. As the material is increased in size and weight, it is to be presumed that this slope may be increased."

4. Sir Henry De la Beche is adduced as an advocate for the upright wall. Now the theory of the upright wall rests entirely upon the assumption that waves have no progressive forward movement or motion, or percussive force, in acting upon erections in the sea, or on coasts, cliffs, or beaches. But Sir H. De la Beche expressly states, that seas in heavy gales of wind are urged onwards in the direction of the winds which raise them; that waves in a breaking state possess enormous force from the weight and velocity of the water thrown forward; and the following extracts from his very able work, "How to Observe Geology," show that he has been erroneously cited, or that he expressed himself in an unguarded manner, when he asserted that upright walls resembling cliffs, are more capable of resisting the percussive effects of waves and seas than slopes."

In the very able work which this eminent geologist published, he delivers the following rules as the result of what he had observed and ascertained with respect to the action of the sea:—

"Properly to estimate the effects of this power, the observer should be present on some exposed coast, such as that of the western part of Ireland, the Land's End, Cornwall, or among the western islands of Scotland, during a heavy gale from the westward, and mark the crash of a heavy Atlantic wave when it strikes the coast. The blow is sometimes so heavy that the rock will seem to tremble beneath his feet. He will generally find in such situations, that though the rocks are scooped and caverned into a thousand fantastic shapes, they are still hard rocks, for no others could continue long to resist the almost incessant action of such an abrading force. Having witnessed such a scene, he will be better able to appreciate the effects, even though the waves be far inferior in size, upon the softer rocks of other coasts.

"The observer should carefully remark the direction of the prevalent winds, and the proportion of those which send the greatest waves, or seas as they are termed, on shore, in order that he may duly appreciate the loss of coast sustained in those directions where the force of the breakers is greatest and most incessant.

"It must not, however, be forgotten that coasts where breakers reach the cliffs at high water, are frequently protected by beaches at low water; and that therefore they are removed from the abrading power of the waves, during all the time that they break on the protecting beaches, a time which varies with the varying state of the tides, and the state of the weather generally.

"Other encroachments are made by the fall of masses of cliff undermined by the waves, the cohesive power of the rock not being equal to its weight, or the action of gravity downwards. If a rock be even sufficiently cohesive in the mass, as to admit of considerable excavation without falling, a time must come, if the breakers continue to work on in the same direction, when the weight of the superincumbent mass would be such that it must fall.

"Where, however, a great mass of cliff does fall, in the manner noticed above, the observer should direct his attention to its conservative influence. To appreciate this, he will consider the hardness of the rock, the position into which it has fallen, and its new power of breaking the waves farther from the coast. If the mass of fallen rock be stratified, much will depend upon the face presented to the breakers; for if it fall so that the plane of the beds remains sloping seaward, it will act as a well-contrived wall erected to defend the cliff; but if the beds should be exposed vertically after the fall, the future destruction of the mass would be far more rapid, and its conservative influence consequently less."

5. No one knows better than I do the ability, the zeal, and the intelligence which Mr. Hartley has displayed in the construction of the Liverpool Docks, and the hydraulic works in the River Mersey; in stating his evidence, as that of a practical man, in favour of the upright wall in the open sea in Dover Bay, I think it best to let him speak for himself.

Question. "You say you prefer an upright wall to any other form for a breakwater; do you know any certain instance of the positive experiment of a wall which has stood the test of time in such an exposed situation, and on such a monstrous scale as Dover Harbour may require?—

Answer. I do not.

"Is it merely matter of opinion?—That is all.

"This perfectly upright wall in Dover Bay in seven fathoms water is an experimental measure you admit?—Quite so as respects myself.

"With respect to the time that it would take to make a breakwater, is that opinion formed upon any knowledge of Dover, or the difficulties of making a wall at Dover?—No, it is only founded upon a supposition of what the sea is in general, and supposing I was to attend to it myself, and had nothing else to do; but it is a vague sort of idea.

"You are not acquainted with the locality?—No, not sufficiently; I have been there two or three times.

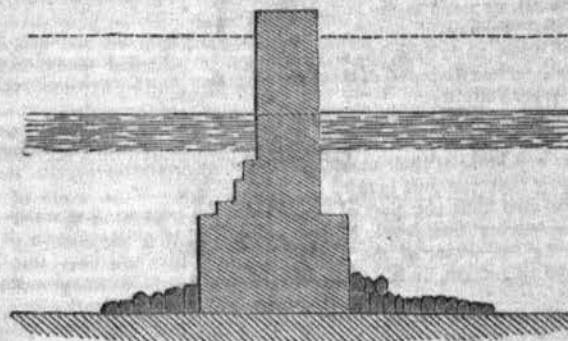
"Have you ever built a wall yourself in such deep water as that?—No, never."

6. My gallant and highly esteemed friend, Major-general Pasley, gives

the following account of his conversion to, or adoption of, the theory of the upright wall: "For many years I paid no attention to this subject, but thought that the long flat slope adopted at Plymouth Breakwater must be the best form for resisting the sea, not only from the reputation of the eminent engineer and naval officers by whom this construction was proposed, but also from the circumstance of its having been approved and carried into execution by order of the Government of that day. But in the year 1842, when this question was publicly discussed at one of the meetings of the Institution of Civil Engineers, at which I was present, after a paper of Lieutenant-colonel Jones, R.E., had been read, in which he gave the preference to upright walls, as being much more secure than breakwaters or flat slopes, and stated his reasons for this opinion, the arguments in favour of the former appeared to me to preponderate. I have since given the subject much attention, and have made inquiries and observations, which have confirmed me in this impression."

7. Captain Vetch is the next authority cited in favour of the upright or nearly upright wall, both from theory and practical observation. On account of the extraordinary difficulties of constructing a harbour of refuge in Dover Bay, he thought that the best mode of executing such a work was by the system of caissons which he proposed. With respect to the combination of a slope with an upright or nearly upright face for the superstructure, he Captain Vetch, said it would be highly advantageous; that it would obviate a great many objections to the present condition of the Plymouth Breakwater; it would prevent the waves breaking over, and would give security to erections on the breakwater itself. The works now going on at Cherbourg, which had been erroneously considered to be an abandonment of the slope in favour of the upright wall, is only a combination of both; this he thinks a great improvement, and adds, that such a breakwater at Dover would be very superior to one entirely sloping. Captain Vetch recommends brick in cement for face work, and suggests blocks of brick firmly agglutinated into a mass by means of a cheap flux between the joints; the mass of brick blocks being subjected to the requisite heat by means of flues or otherwise.

8. M. M. Reibell is the next authority adduced in support of the upright wall; and a sketch, of which the annexed is a copy, is inserted in the Proceedings of the Commission to sustain, as it would appear, the



proposition of the upright wall, which it is inferred the French engineers as a body, approve, and would adopt, if the breakwater in Cherbourg Bay were to be commenced *de novo*.

Captain Washington, in his report on the breakwater at Cherbourg states, that "M. Reibell, the present engineer, is decidedly in favour of an upright wall, and recommends the form shown in the annexed sketch as the best for opposing the shock of the waves."

9. Mr. Brunel is next adduced as having given his opinion in favour of an upright wall for the construction of breakwaters. But Mr. Brunel was not examined before the Commission, and the only opinion which he has given upon this subject is that contained in the annexed extract of a letter from Mr. Brunel, addressed to the Chairman, dated 19th June 1844: "Upon one point upon which I understand the Commissioners to have sought an opinion, I have no hesitation in expressing my concurrence in those which I am told have been generally expressed in favour of vertical sea-walls, in lieu of slopes, where the nature of the material to be used, and other circumstances, admit of such a plan being efficiently and economically carried out."

10. Mr. Bremner is next adduced as an authority in favour of the upright wall.

With the greatest possible respect for all these able and eminent men, I must say, that I do not find any thing in what they have adduced that can, in my judgment, warrant the adoption of the mode of construction which they recommend; it does not rest upon any proved principle, is untried upon any sufficient scale to justify its adoption in a great national undertaking, and all agree in designating it experimental.

When I find it stated, in the summing up of the Commission, that the opinion of Mr. Alan Stevenson in favour of a sloping breakwater is the "sole exception" to those of the other men of distinguished science and practical observation, who have been called upon to advise the Commission on this important subject,—I feel bound to interpose against the conclusion arrived at, Sir John Rennie, Mr. George Rennie, Mr. Cubitt, Mr. William Stuart, as well as Mr. Alan Stevenson, who all disapprove of any attempt to construct an upright wall in the open sea at Dover; and they distinctly express their opinion, apprehension, or conviction, that such attempt would

end in total failure; and when to this I shall have added what I have yet to say upon the subject of Cherbourg, Plymouth, and Delaware breakwaters, works actually constructed on the principles which the new theory would abandon, and shall have adduced the opinion of the most eminent and enlightened engineer of France, I trust I shall be considered to have made a good case in support of this dissent.

There is no part of the Report of the 28th January 1846 from which I more decidedly dissent than that which refers to Cherbourg Breakwater as a failure, and as "an attempt which may serve as a warning to those who may have to decide upon the construction of such works in this country," that they avoid entirely the principles upon which that work has been constructed.

In the Annex (M.) is a brief historical account of Cherbourg Breakwater from the commencement, together with an extract of the Report of the Commission of the Institute of France, of which Prony and Charles Dupin were members, and Girard rapporteur. These eminent men, after a careful inspection of that work, and after having investigated the whole process of its execution throughout, reported that the failures which had taken place arose, not from its having a sloping face, but that the slopes were not long enough to resist the action of the waves; that no constant degree of slope is calculated to resist the different actions of the sea at different depths; that these actions reduced gradually the masses of stone forming the original dyke, to a profile having different degrees of slope, and that this necessarily diminished the height of the work at different times. They added that the whole mass was thus, at length, brought into a state of the most perfect stability; and all this was verified by the United States Commission.

The first great lesson really taught by the work in Cherbourg Bay, as a warning what to avoid, is that the system of caissoning should not be adopted; the next lesson is to avoid the use of small stones deposited *à pierre perdue*; the third lesson is, not to construct the sea-face of breakwaters in one uniform slope from the bottom, but to form the profile with two slopes, and to make the slope far longer than that which was originally designed for the work. The result of this extensive experiment demonstrates first, how insufficient and incompetent mere theory and speculation are, to fix within precise limits the degrees of resistance which should be given to a work exposed to the violent efforts of the sea.

We find that the mass of materials originally deposited in Cherbourg Bay, was heaped up so as to form too steep a slope, and that the agency of tempestuous waves has disposed of them by reduction to a form which secures their permanent stability:

That the part of a breakwater which is above the highest level of spring tides, is so little exposed to the action of waves (which must have lost by their ascent a portion of their momentum ere they arrive there), that it may be more steep than the part below.

We learn also that the part of the breakwater between low water and high water, spring tide level, is exposed to the greatest violence of the waves during the whole of the rise and fall of tides; and that there the slope should be longest, or the inclination of the face to the horizon should be the least.

Captain Washington states, in his report on the breakwater at Cherbourg, "that the long slope of ten to one, formed by the action of the waves, from low-water mark upwards, has not varied, not even in the gales of 1808, 1824, and 1836, the most memorable on record." There cannot be better evidence of the stability of the long slope.

That the part of the breakwater for a certain distance below the lowest spring tide, is exposed only to the shock of waves towards the termination of the fall and the commencement of the rise of tide; that there the slope may be steeper, or the inclination to the horizon greater; whilst at the lowest part of all, or that which remains permanently submerged, the slope may be still more steep, or have the greatest inclination to the horizon.

With respect to the magnitude of materials, we find that small stones have not sufficient stability to withstand even a moderate action of waves.

That stones of from one and a half to two tons weight, are sufficient to resist the effects of a moderate sea.

That blocks considerably larger are required to withstand violent seas.

That when small materials are used, it is indispensable to cover them with blocks of large dimensions.

That very large blocks should be placed towards the top of the work, to compensate by their weight the loss of stability caused by the total immersion of the materials beneath, for these lose as much of their weight in water, as is equal to the weight of water displaced.

The last fact to be noticed respecting the work at Cherbourg constitutes a very decided warning against the use of blocks of concrete, which was proposed by Captain Denison, November 21, 1845; for the application of this material on a large scale has entirely failed; the blocks of concrete having broken to pieces.

The imperfections of the original project being corrected, the breakwater at Cherbourg is now proceeding rapidly to completion; and far from being a warning that those who have to decide upon the construction of a Harbour of Refuge in Dover Bay, or elsewhere, should avoid the principles and reject the form which has been observed in its construction, it demonstrates in the most forcible manner, that the theory of the upright wall should be rejected, and that in its place should be adopted the well-trying slope, or rather a combination of different slopes; while a nearly upright wall may be formed above, to serve for the facing of a parapet like that which crowns the work at the French port.

Now, persons who read cursorily that part of the Report to which I

have referred, may imagine that the old dyke at Cherbourg had been taken down, and that the vertical wall which has recently been built, is raised from the natural bed of the sea, to the exclusion of the slope; whereas it is, in fact, merely a parapet with a nearly vertical face placed on the original breakwater, to prevent the waves from rushing over the *terre-plein*, after their force had been expended or greatly diminished, in ascending the long slope or glacis in its front.

I repeat now, on the authority of the very highest, the most experienced civil and military engineer of France, or probably that the world ever knew, that "all the enlightened engineers of France do continue to adopt, and will continue to construct breakwaters with inclined slopes, and do reject the theory of the upright wall; that the only alteration they would make if the work were to do over again, is in the degree of slope, which they would make variable according to the nature, specific gravity, and magnitude of the materials used; that the walls now being erected at Cherbourg, are not upright from the naked bottom of the sea, but built as a parapet, upon a well-consolidated basis; this being the breakwater previously formed *à pierre perdue*, whose slope has different degrees of inclination to the horizon, according as the action of the sea has reduced the original mass." That great work now stands in the form of a combination of the slope with the upright face for the superstructure; a profile which Rendel, Rennie, Cubitt, Vetch, Stuart, Colonel Harry Jones, Vignoles, and others recommend, but which Professor Airy says, speaking of an entire breakwater so formed, is, theoretically, "without doubt the worst of all."

That there may be no mistake upon this important matter in reference to Cherbourg Breakwater, unquestionably the greatest piece of hydraulic architecture that has ever been executed, I annex a profile, showing a combina-



tion of the long slope with the vertical parapet and its fore-slope of stones; and I add the reasons which induced the French engineers 14 years ago to recommend such a superstructure. This combination was proposed for the completion of the breakwater, by Mons. Duparc, director of hydraulic works at Cherbourg, and sanctioned without modifications by the Minister of Marine in April 1832, on the advice of a special commission, to which that proposition had been referred; but so far from pulling down the ancient dyke, as stated in the Report, it was raised from the level to which it had been reduced from not having slope enough, by depositing large blocks of rough stone up to the height of low-water spring tides; and on it there was laid a mass of concrete, about 3 feet thick, on which a wall or quay is built to the height of 12 feet above high-water spring tides. The exterior side of this quay or wall, is protected by a fore-shore of great blocks of stone, extending in a slope of 120 feet to the depth of 21 feet below low-water mark. The object of these blocks is stated by Mr. Viria to have been two-fold. The inclined surface of this fore-slope makes, with the face of the wall, a re-entering angle which might have been avoided in part by adopting the concave profile of Mons. Emy, but which in this case was not thought necessary, inasmuch as the artificial beach of great masses of stone the principal object of which was to give to the slope of the dyke perfect stability, produced in addition an important effect in resisting the action of the waves at low water. It is found, in fact, that the waves which break on the surface of a long slope, have time to deaden their force against the asperities of the blocks which form the slope, before they strike the re-entering angle of the foundation; and as the sea rises, and the time of high water approaches, the slope in front produces the effect of an ordinary beach in turning and throwing up the waves, which would otherwise break against the wall with extreme violence at the moment of their maximum of intensity.

Lieut.-General Sir Howard Douglas concludes by giving his dissent to the statement made by the Commissioners in their Report, "that they do not approve fully of any of the plans sent in."

And he objects to the use of blocks of concrete, or of brick set in cement, or to any other artificial material, as substitutes for stone, for the formation of national works, which, if not to be constructed on sound and well-trying principles, with materials of the best and most enduring descriptions, should not be attempted; and he also dissents to the recommendation of a majority of the Commission, for the adoption of masses of brick, as proposed by Mr. Rendel.

And lastly, Sir Howard dissents from any extension of the area to be comprehended by the breakwater, as recommended in the Report of 1844; and more especially from the suppression of the eastern opening; without such opening, the proposed Harbour of Refuge would be deprived of an essential condition which all such harbours should possess, that of facility of egress or escape at all times and tides, and in all weathers; and he is convinced that by omitting to form this opening, the proposed enclosure would become to such a degree a close harbour, as greatly to increase and accelerate the progress of the evil to which all close harbours are liable, that of rapidly silting up.

RENAISSANCE DECORATIONS.

An Account of the Palace of Blois and Palace of Chambord, France, especially as to the Decorations. By JOHN GREGORY CRACE. Read at the Royal Institute of British Architects, May 31.

Having been much interested during an excursion made to Touraine, in the autumn of last year, by visits to Blois, Chambord, Chenouceaux, Amboise, and other monuments of the Renaissance style of architecture, which abound in that district of France, I am induced to lay before you a description of what I saw at the two former of those places, Blois and Chambord.

The town of Blois, on the river Loire, is of very considerable antiquity, and contains many objects highly interesting to the lover of mediæval art. It lies between two hills, on one of which is the cathedral, on the other the palace or castle.

The Castle of Blois is supposed to stand on the site of a Roman camp. Mention is made of it in history about the ninth century. I do not attempt to detail to you its various possessors, but merely observe, that in the year 1292 it first came to the De Chatillons, who are supposed to have built parts of the castle. Froissart, who was chaplain to Guy de Chatillon, Count de Blois, says, that it was "grand and strong, and one of the handsomest in France." By this Count Guy it was sold, as indignantly mentioned by Froissart, to Louis d'Orleans, brother to King Charles VI., who took possession in 1397. The Orleans retained the property till their descendant became King of France under the title of Louis XII.; it then remained crown property till Louis XIII. bestowed it on his brother, Gaston d'Orleans, at whose death it seems to have reverted to the crown, and at the Revolution to have become public property. Viewed as you ascend from the town, the castle appears rising from a mass of rock, on which is an imposing base of solid masonry, giving the idea of a fortress of considerable strength. Passing the west front of the building, you arrive at the Place des Jesuites, when the eye is struck with the magnificent north front of the quarter erected by Francis I. This front is entirely of stone; partly in two, and partly in three stories. The windows are in arched recesses, relieved with deep colouring, producing a rich and powerful effect; between the windows are pilasters, and where these are double they are separated by niches and deep recesses. Picturesque bays also project in various parts of this façade. A large circular tower marks the old *tour des oubliettes*, or the *donjon*, considered one of the oldest parts of the building. The roof is separated from the entablature by a series of columns, thus forming an open gallery, and from the pedestals of these columns project tremendous gargles. To my mind the effect of this front is truly beautiful, and a successful example of the introduction of colour to architectural exterior. Part of the building was erected by the architect Mansard, by direction of Gaston d'Orleans, in the reign of Louis XIII., in a style of art seen to great disadvantage beside the beautiful front I have attempted to describe.

Leaving the Place, we approach the east front of the exterior, constructed by Louis XII. It is of brick, with ornamental stone dressings. I regret not being able to show a view of this front, which is very picturesque. I sketched one window, and also—what is the principal object—the canopied recess that formerly contained the equestrian statue of King Louis XII. This recess, surmounted by its canopy, is of stone beautifully wrought. I have ventured to restore, in the drawing, the colouring to the back-ground, powdered with gold *fleurs-de-lis*, and to replace the statue as it existed previous to the Revolution, from a drawing in a manuscript by Felibien. On the fascia under the statue was formerly placed an inscription, in Latin, which may be thus translated:—

"Where by the grace of God Louis was born,
Here also, with a noble hand, he assumed the royal sceptre.
Happy the day which announced the coming of so great a monarch.
France could not have found a king more worthy of her."

That statue and the inscription are alike removed, and on the same fascia is now written "Caserne d'Infanterie." The palace of Louis XII. "the father of his people," is now a barrack.

Under this canopy is an archway, forming the principal entrance to the interior court of the palace. This court consists of an irregular square, the four sides of which are in as many styles of architecture. On the south, the Gothic of the fifteenth century; on the east, the elaborately ornamented Gothic of Louis XII.; on the north, the elegant *renaissance* of Francis I.; and on the west, the Franco-Italian style of Mansard: all these, full of irregularities, produce an *ensemble* picturesque and charming to the eyes of all, and most interesting to the lover of art.

The south side of the building, looking towards the interior court, was altered and partly rebuilt by the old Dukes of Orleans. It is of

an unpretending style of domestic Gothic, the outer walls being of brick, the windows and dressings of stone. In this quarter, in addition to various apartments, is the old chapel of St. Calais, which dates from a much earlier period; a view of it can be seen in Androuet Ducerceau.

The east side of the court is the building erected by Louis XII.; it is of red brick, with window dressings, string courses, and enrichments of stone richly carved; above, rises a high roof formerly crested with gilt metal work, from which project dormers in stone of beautiful tracery, the whole resting in front on a colonnade, forming a sort of cloister; the stone pillars being diapered with trellis work, in which were formerly *fleurs-de-lis* and ermines. This quarter contains the apartments occupied by King Louis XII., which, though now under one universal coat of whitewash and all in the occupation of soldiers, were formerly fitted up with regal splendour.

Here, in the year 1501, King Louis XII. received in this building the Archduke Philip of Austria, and a chronicler of the period gives a most complete and interesting description of the palace as it then appeared. The east front was then just finished, its network of stone shown in all its brilliant freshness on its bright brick ground; the carvings were seen in all their perfection; a profusion of *fleurs-de-lis* and ermines, sculptured or painted, were spread over the building; gold, purple, and azure dazzled the eye in every direction, even up to the roof, whose crestings and enrichments were also gilt; over every door was seen the royal badge of the porcupine spreading out its quills, and over the entrance archway was the splendid statue of the king himself, young and handsome, noble and full of grace, as he then was.

Nor was the interior less magnificently decorated: rich tapestries, wrought in figures or flowers, or ornaments, furnished the walls; over the floors were spread thick carpets. The chimney-pieces were blazoned with heraldic shields, paintings, and devices; the joists of the ceilings (for they were unplastered then) glittered with gilding and elegant decoration; furniture, carved with the utmost delicacy of finish; beds, covered in the richest stuffs, embroidered in gold and in silks of all colours—these ornamented the apartments. And as if to recall the salutary thought of death, in the midst of all that was gay and joyful there was painted, as was usual then, the celebrated dance, *Macabre*, on the walls under the piazza or colonnade.

The king was proud of his palace, and right royally did he receive his visitors. Our chronicler, after describing with much interesting detail the procession by torchlight, the reception of the archduke and duchess, and the ceremonies of introduction to the king and queen, continues his description of the apartments of the palace.

"The Grand Hall, by which the archduke and duchess entered, was of great size, and hung with a tapestry of the Destruction of Troy; and in the like manner also a chapel at the end of the hall. The room where the king dined, and where the archduchess was, was hung with a tapestry of a battle. Over the chimney was a grand mantle of cloth of gold, craped very rich. The chamber of young Madame Claude was next to the king's, and was hung with a tapestry of pastorals, all small, with inscriptions, which was very fine. Afterwards came the chamber of the queen, hung with a tapestry of strange beasts and birds, with figures from foreign countries; and in said room was a bed, all dressed out with cloth of gold, and above the bed a canopy of crimson damask. In the lodgings of the archduke there was a gallery, hung with tapestry of the deeds of the Trojans; after that a grand chamber, hung with tapestry of the actions of Alexander the Great, and a mantle over the chimney, of cloth of gold, craped. From ceiling of this room hung two chandeliers, marvellously large, of silver, made crossways, for placing on each four flambeaux, which chandeliers hung by great chains of silver. At the end of this room was the chamber of the archduchess, where the said lady and gentleman slept, which was hung with cloth of gold, wove with black and red. Here were two beds, of which the one in which they slept was of stuff embroidered in gold, and curtains of the same, lined with white damask; and above this bed was a canopy, the top of cloth of gold, the curtains of taffety, yellow and red.

"The other bed was furnished in the same manner, and on each were coverlets of cloth of gold, and inside them sheets of linen from Holland. All around the beds, and on the buffet were carpets of cloth of gold. In the corner by the bed was a gilt chair, admirably wrought by Italians, of which the seat, &c. was covered with cloth of gold, fringed all round with fringes of gold and silver. Before the chimney was another chair, also covered with cloth of gold, and there was carpet of the same stuff under it; also, there were many rich cushions in the room to sit upon."

And thus goes on our chronicler, describing every room: one hung with crimson velvet embroidered with K's and A's, crowned; another with crimson embroidered with cords and the arms of Burgundy;

another with brocade, yellow and grey, with S's in black velvet; another with crimson satin embroidered in flames of fire, and at the angles and in the centre were lions in wreaths, entirely covered in pearls, and which were mighty rich to see, and cost 40 to 50,000 ducats. And the chronicler further takes care to remark, that all the said stuffs and tapestries were as fresh and good as new, and that the floors of all the rooms were covered with carpets of velvet, so that nothing of the floors was seen.

Thus was furnished this palace of a king of France at a time contemporary with the reign of our Henry VII.

At each extremity of the front of Louis XII., and forming part of the work erected by him, is a square tower of picturesque appearance. It contains a staircase of considerable elegance. The stairs radiate round a centre shaft, which is formed of clustering columns terminating in a crown at top, from which rises a vaulted ceiling. Though the construction and many of the details are Gothic, yet some of the ornaments partake of an Italian character.

From this staircase we pass to the part of the palace the most historically famous, the ancient *Salle des Etats*, a large building, of somewhat plain appearance, dating about the thirteenth century, although several alterations of a later period have been made to its windows, &c. In this spacious hall the three estates of the kingdom used formerly to assemble. It has a rude and bare appearance; down the centre range a series of pointed arches, resting on columns supporting the roof, and dividing the ceiling into two parts, which are arched, and simply covered with flat boards. In the reign of Henry III. the states were summoned to meet here; and it was during their assembly that the powerful Duc de Guise was murdered in one of the apartments of the palace. The hall was then richly ornamented; the walls were hung with splendid tapestry, worked in figures, relieved with gold; the columns covered with purple velvet, powdered with gold *fleurs-de-lis*; and the ceiling was also covered with tapestry. A platform was raised nearly in the centre, behind one of the arches, on which was placed the throne of the king, all being covered with purple velvet, powdered with gold *fleurs-de-lis*, and on this, and on the steps to it, were seats for the blood royal; behind stood the archers of the guard; in front, and on either side, were the three estates, and in galleries at the end were seats for ladies;—the common people were also allowed to enter within certain barriers. The king descended from his apartments into the hall by wooden stairs at the end, but which stairs are now removed.

Adjoining the ancient *Salle des Etats*, and forming the northern side of the quadrangle, is that quarter of the palace erected by Francis I. This front, by the elegance of its proportions, the beauty of its details, and the grandeur of its effect, is by far the most imposing feature in the whole building, and a most tasteful specimen of the Renaissance style of architecture. The exterior front, towards the *Place des Jesuites*, I have already described; this, towards the interior court, is altogether different: here we have more elaborate decoration and greater delicacy of finish. It is entirely of stone, and composed of two principal floors, decorated by pilasters and panelings; round the windows are interlaced enrichments, and the reveals are panelled, and were, I suspect, formerly relieved with colour. Above is an entablature of considerable richness and beautiful effect. Its modillions project to some extent, and above them is a kind of machicolation, containing shell enrichments in its recesses; over this rises an ornamental balustrade, formed of the letters F and C, for the initials of Francis I. and Claude of France. From the roof project dormer windows of graceful outline; and even the chimney-shafts are enriched, and by no means unworthy of remark. The roof itself was formerly crested with an ornament composed of *fleurs-de-lis*, gilded. Below was formerly a colonnade supporting a gallery, as given by Ducerceau, which, although now removed, is about to be restored. But the principal object in this front, and which gives a charm to the whole, is the grand open staircase, situate about the centre of the façade, and projecting in front of it. This has lately been restored, and now shines forth in the full beauty of all its delicate and tasteful workmanship. The balustrades are formed of open carvings of foliage and the crawling salamander. Niches of most elaborate detail and elegant arabesques adorn the shafts of the pilasters; twining foliage is sculptured round the mouldings of the window openings;—in every part does ornament seem to clothe this magnificent work of art like the delicate foliage and clinging tendrils of the ivy clustering round a tree, yet nowhere does it superabound or appear misplaced.

The interior of this staircase is also ornamented with carved niches and enrichments; mounting its steps, we enter the suite of apartments on the first floor, being those formerly occupied by Queen Catherine de Medici. The first is called the *Salle des Gardes*, or guard chamber, a room of considerable size. The chimney-piece of stone, though massive in construction, is to be noticed for the elegance and richness

of its ornaments; the stair door-frame is decorated, and has over it the salamander in flames, the badge of Francis I. The ceiling here, as in most of the rooms in this building, is formed of beams, which are, in fact, the floor-joists of the room above; the effect of these, when painted, is by no means unpleasing. I made a sketch of the decorations lately executed on this ceiling, in which the initials, arms, and badges are mingled, with forcible contrasts of colour; whether the precise pattern is a restoration or not, I had no means of discovering; but there are many old examples of this mode of ornamenting the ceilings still remaining at Chenouceaux, Fontainebleau, and other places; and in Venice, almost all the older palaces have the ceilings decorated in this way, with arabesques and inlaid ornaments of great variety and beauty. The walls of this chamber are now bare, so they are all, in fact; nothing now remains of the splendour that dazzled the eyes, or the works of art that delighted the mind, during the time of Francis I. We pass through a multitude of rooms, but all are desolate alike—each has suffered the distressing calamity of whitewash—not a vestige of furniture, not a hanging remains. The chimney-pieces alone attest the magnificence and beauty with which the remainder must have been ornamented. I anticipated the pleasure of sketching these, which possess a rich fund of *renaissance* art, but a custodian abruptly prohibited my making further drawings; and I was thus prevented taking many details in the interior that might have proved interesting. The state-rooms seem to have been situated on this court-side of the building; and on the other, looking towards the *Place des Jesuites*, were the large bed-room and private apartments of the queen; amongst others, her cabinet. In this the walls are covered by carved panelling, the details of which are executed with much spirit and taste.

Again mounting the open staircase, we reach the floor above, the disposition of the rooms on which is exactly similar to the one we have left. These were the apartments occupied by King Henry III. You enter first the *Salle des Gardes*, which served also as a council chamber; from hence you pass into the king's bed-room, a very spacious apartment looking towards the *Place des Jesuites*. Here occurred the tragedy of the murder of the celebrated Duc de Guise.

The cabinet of the king is next this chamber; it is a small room, which still retains some traces of decorations. On the ceiling are to be distinguished slight remains of colouring, and arabesque ornament in fresco may still be seen on the linings of the window recess. On the left of the bed-chamber you enter a sort of passage which leads to the old Tour des Oubliettes or Donjon, of which so many horrors are retailed; at present nothing but bare walls of considerable thickness are to be seen.

Above this second floor are a range of rooms in the roof, but these contain no ornamental or interesting feature of any kind except that a most extensive view of the adjoining country is to be obtained from the open gallery outside them.

Of the west front I have little to say; it is that erected by Gaston d'Orleans, in the time of Louis XIII. As a structure away from these middle age remains, it would probably be admired, but here it is thoroughly out of place. It stands on the site of a part of the ancient château erected by the old Dukes of Orleans.

Before leaving the Château de Blois, I must not omit to call attention to an old tower, used subsequently as an observatory and astrological study by Catherine de Medici.

THE PALACE OF CHAMBORD.

Crossing the Loire, you pass along a sandy road through a district of vineyards, till you enter a forest, in the midst of which, and at about four leagues from Blois, lies the celebrated *Château de Chambord*.

It is difficult to describe the effect it first creates upon the mind—it looks so perfectly unlike any thing one has ever seen before. Below—its massive round towers and perfect simplicity give the idea of the strong fortress of ancient date. Above—the wildest confusion and profusion of the most fantastic, the most beautiful, and the ugliest forms, all mingle together, and produce an architectural scene that cannot be imagined.

The building is immense, and has an appearance of extreme grandeur, stateliness, and solidity.

Androuet Ducerceau says, "All this edifice is admirable, by reason of its great massiveness, and presents an effect wondrously superb on account of the immensity of work in it."

It is said to have been begun to be built by Francis I. after his return from Spain, about the year 1526, and that nearly 2,000 workmen were employed on it for many years.

The centre building is in the form of a square, having at the angles four great round towers about 60 feet in diameter. This centre square building is inclosed, as it were, within an exterior court, having at its angles round towers also. Of these, the two in a line with the prin-

principal building nearly resemble those of the centre, with which they are connected by a continuation of the front; and the two towers at the other extremities are smaller, and connected with an insignificant range of buildings for stables, offices, &c., and which, though built by Mansard, in the time of Gaston d'Orleans, are a complete eye-sore contrasted with the more ancient building.

I believe it is unknown who was the architect of Chambord. Primaticcio has been mentioned, and it seems to me likely to have been designed by an artist accustomed to flights of the imagination, rather than by an architect who would have studied greater appropriateness in the forms.

Though it is not so stated in any account that I am aware of, I cannot help fancying that the round towers must be the remains of some older building, so completely does the plan resemble the inclosed strong-hold, the old *maison-forte* of the earlier middle ages.

Three ranges of pilasters at almost regular intervals, girt the exterior of the principal building, which is partly relieved with open galleries; above these is an entablature, showing the same kind of machicolation and shell-work as in the building of Francis, at Blois; and above the cornice is a balustrade, which girts the platform on the roof. Towards the interior of the court, the architecture possesses more variety, and at the two angles is an open staircase of beautiful design, resembling the one at Blois.

But the roof is the glory of Chambord. The whole top of the building is one grand terrace, paved like a marble court.

Immense pointed roofs, more than 50 feet high, rise above the towers like ornamented pyramids studded with magnificent dormers and gables, intermingled with elegant chimney shafts and towers, decorated with niches and flanked with columns in most beautiful proportion.

Elevated above all the rest is the grand centre staircase of the building (of the interior of which I will speak presently). This, as it rises above the platform, is surrounded by columns supporting a gallery, from which spring eight grand flying buttresses, ornamented with gigantic salamanders and supporting the cupola, which terminates in the remains of the famous *fleur-de-lis*, which gave the name to this crowning glory the "*Tour de la Fleur-de-Lis*."

There are published views to explain, in some degree, the appearance of this wonderful work; but no drawing can convey the full effect of this labyrinth of palaces, seen at different points of view, as you wander about this magnificent platform.

The various towers and chimney-shafts are of most elegant proportion; but the details, though of beautiful design, are rarely executed with the finish of the work at Blois, which they much resemble.

The caps of the pilasters, and the corbels at their base, are of infinite variety.

On the gable and the buttress of centre tower may be remarked dark lozenges and circles, and also a sort of fluting. To these I beg to call your attention; for though looking from below like inlaid marble, they are in fact nothing but pieces of slate nailed on the surface.

The interior arrangement of the château is extremely peculiar. On each floor one vast apartment stretches in the form of a cross, from back to front, and from side to side, of the building; and in the centre of the cross is the celebrated double staircase, rising through every floor, and forming the highest object in the roof above.

In each of the four angles left by the cross is a separate suite of apartments, including also others within the angle towers, and from two of these, again, there is a communication by another suite of rooms with the two outer towers on the same front. The large cross-shaped chambers are called *Salles des Gardes*; but I cannot think that rooms of such magnitude, communicating with every quarter of the château, could ever all of them have been intended as guard chambers. I rather imagine, considering that Chambord was erected by Francis I. as a hunting palace, that it was arranged on this singular plan as a place where state was to be laid aside, and that these halls were places of general rendezvous. Their ceilings are vaulted and divided into panellings, filled with the initial F and the royal salamander in flames alternately. In one of these curious chambers, where scenes of state and ceremony have often occurred, Moliere's play of the "*Bourgeois Gentilhomme*" was represented for the first time, before Louis XIV.

The grand staircase is wonderful—wonderful for the effect it produces and the beauty of its proportion and its ornaments, rather than for any peculiar difficulty of construction. Its construction may be thus described:—the outer diameter of the staircase is, I suppose, about 30 feet; in the centre of this is an inner wall, in diameter about 10 feet; between these two circles the stairs wind up in a double spiral, commencing at opposite points, so that parties entering at each, in ascending, see each other repeatedly through openings, but do not meet till they arrive at the various floors. The exterior of the staircase is decorated, and the interior wall is also highly ornamented with

a variety of beautiful niches. The salamander in flames and the initial F are also introduced, the latter surrounded with a frame of cords—emblem of the Cordillieres to which the king's mother belonged. Of the termination of this staircase above the roof I have already spoken.

Of the four hundred and forty chambers which this mighty château is said to contain, there is not one that has escaped the distressing evil of whitewash, and few of them retain any ornament indicating their former use or recalling their former grandeur. I sketched a ceiling of a small vaulted room, said to be a private chapel, where the panels resembled those in the *Salles des Gardes*; and I remarked a chamber where there were indications that a painted frieze, three feet deep, had been; but everywhere the walls are bare—not a vestige remains of any kind of hanging or decoration. Destruction, the most ruthless that can be conceived, has swept over the whole interior: all the furniture, the paintings, the wainscoting of the walls, the very doors, the windows, were burnt, broken, or stolen at the time of the Revolution.

Yet, what must the chambers have been at the time of the royal Francis, who so loved to surround himself with objects of art!—what thousands of works produced under his fostering care still remain to us! Who can doubt that the rooms, so wretched now, were one blaze of splendour then? that, besides the paintings of Primaticcio, and the frescoes of Jean Coussin, who were engaged there for years, there were assembled there the choicest works of the greatest masters—groups in marble by the rarest Italian hands; bronzes by Cellini, and, equally precious, his tasteful ornaments and vases in gold and silver; delicate carvings in ivory; enamels, by Leonard de Limoges; glasses from Venice. Fancy that the walls were hung with the richest tapestry, or leather, or brocade—that the ceilings were blazoned with colour and glittered with gold—that tasteful furniture, which Il Rosso and Primaticcio disdained not to design, filled the various apartments; picture the king, in the midst of his brilliant court, dazzling the eye with the richness of the costume and the beauty of the ladies—and the mind will indeed conceive a scene at Chambord, in vivid contrast to now what meets the view.

ON THE INDUCTION OF ATMOSPHERIC ELECTRICITY ON THE WIRES OF THE ELECTRIC TELEGRAPH.

By PROFESSOR JOSEPH HENRY.

(Continued from page 177.)

4. Powerful electrical currents are produced in the wires of the telegraph by every flash of lightning which takes place within many miles of the line, by the action of dynamic induction; which differs from the action last described, in being the result of the influence of electricity *in motion* on the natural electricity of the conductor. The effect of this induction, which is the most fruitful source of disturbance, will be best illustrated by an account of some experiments of my own, presented to the Society in 1843. A copper wire was suspended by silk strings around the ceiling of an upper room, so as to form a parallelogram of about sixty feet by thirty on the sides; and in the cellar of the same building, immediately below, another parallelogram of the same dimensions was placed. When a spark from an electrical machine was transmitted through the upper parallelogram, an induced current was developed in the lower one, sufficiently powerful to magnetize needles, although two floors intervened, and the conductors were separated to the distance of thirty feet. In this experiment, no electricity passed through the floors from one conductor to the other; the effect was entirely due to the repulsive action of the electricity in motion in the upper wire on the natural electricity of the lower. In another experiment, two wires, about 400 feet long, were stretched parallel to each other between two buildings; a spark of electricity sent through one produced a current in the other, though the two were separated to the distance of 300 feet; and from all the experiments, it was concluded that the distance might be indefinitely increased, provided the wires were lengthened in a corresponding ratio.

That the same effect is produced by the repulsive action of the electrical discharge in the heavens, is shown by the following modification of the foregoing arrangement. One of the wires was removed, and the other so lengthened at one end to pass into my study, and thence through a cellar window into an adjacent well. With every flash of lightning which took place in the heavens, within at least a circle of twenty miles around Princeton, needles were magnetized in the study by the induced current developed in the wire. The same effect was produced by soldering a wire to the metallic roof of the house, and passing it down into the well; at every flash of lightning a series of currents in alternate directions was produced in the wire.

I was also led, from these results, to infer that induced currents must traverse the line of a railroad, and this I found to be the case. Sparks were seen at the breaks in the continuity of the rail, with every flash of a distant thunder-cloud.

Similar effects, but in a greater degree, must be produced on the wire of the telegraph by every discharge in the heavens; and the phenomena which I witnessed on the 19th of June in the telegraph office in Philadelphia were, I am sure, of this kind. In the midst of the hurry of the transmission of the congressional intelligence from Washington to Philadelphia, and thence to New York the apparatus began to work irregularly. The operator at each end of the line announced at the same time a storm at Washington, and another at Jersey City. The portion of the circuit of the telegraph which entered the building, and was connected with one pole of the galvanic battery, happened to pass within the distance of less than an inch of the wire which served to form the connexion of the other pole with the earth. Across this space, at an interval of every few minutes, a series of sparks in rapid succession, was observed to pass; and when one of the storms arrived so near Philadelphia that the lightning could be seen, each series of sparks was found to be simultaneous with a flash in the heavens. Now we cannot suppose for a moment that the wire was actually struck at the time each flash took place; and indeed it was observed that the sparks were produced when the cloud and flash were at the distance of several miles to the east of the line of the wire. The inevitable conclusion is, that all the exhibition of electrical phenomena witnessed during the afternoon was purely the effect of induction, or the mere disturbance of the natural electricity of the wire at a distance, without any transfer of the fluid from the cloud to the apparatus.

The discharge between the two portions of the wire continued for more than an hour, when the effect became so powerful, that the superintendent, alarmed for the safety of the building, connected the long wire with the city gas-pipes, and thus transmitted the current silently to the ground. I was surprised at the quantity and intensity of the current; it is well known, that to affect a common galvanometer with ordinary electricity, requires the discharge of a large battery; but such was the quantity of the induced current exhibited on this occasion, that the needle of an ordinary vertical galvanometer, with a short wire, and apparently of little sensibility, was moved several degrees.

The pungency of the spark was also, as might have been expected, very great. When a small break was made in the circuit, and the parts joined by the fore-finger and thumb, the discharge transmitted through the hand affected the whole arm up to the shoulder. I was informed by the superintendent, that on another occasion a spark passed over the surface of the spool of wire, surrounding the legs of the horse-shoe magnet at right angles to the spires; and such was its intensity and quantity, that all the wires across which it passed were melted at points in the same straight line as if they had been cut in two by a sharp knife.

The effects of the powerful discharges from the clouds may be prevented in a great degree, by erecting at intervals along the line, and aside of the supporting poles, a metallic wire, connected with the earth at the lower end, and terminating above at the distance of about half an inch from the wire of the telegraph. By this arrangement the insulation of the conductor will not be interfered with, while the greater portion of the charge will be drawn off. I think the precaution of great importance at places where the line crosses a river, and is supported on high poles; also in the vicinity of the office of the telegraph, where a discharge, falling on the wire near the station, might send a current into the house of sufficient quantity to produce serious accidents. The fate of Professor Richman, of St. Petersburg, should be recollected, who was killed by a flash from a small wire, which entered his house from an elevated pole while he was experimenting on atmospheric electricity.

The danger, however, which has been apprehended from the electricity leaving the wire and discharging itself into a person on the road, is, I think, very small; electricity of sufficient intensity to strike a person at the distance of eight or ten feet from the wire, would, in preference, be conducted down the nearest pole. It will, however, in all cases be most prudent to keep at a proper distance from the wire during the existence of a thunder-storm in the neighbourhood.

It may be mentioned as an interesting fact, derived from two independent sources of information, that large numbers of small birds have been seen suspended by the claws from the wire of the telegraph. They had in all probability been instantaneously killed, either by a direct discharge, or an induced current from a distant cloud, while they were resting on the wire.

Though accidents to the operators, from the direct discharge, may be prevented by the method before mentioned, yet the effect on the ma-

chine cannot be entirely obviated; the residual current which escapes the discharge along the perpendicular wires, must neutralise for a moment the current of the battery, and produce irregularity of action in the apparatus.

The direct discharge from the cloud on the wire is, comparatively, not a frequent occurrence, while the dynamic inductive influence must be a source of constant disturbance during the season of thunder-storms; and no other method presents itself to my mind at this time for obviating the effect, but that of increasing the size of the battery, and diminishing the sensibility of the magnet, so that at least the smaller induced currents may not be felt by the machine. It must be recollected that the inductive influence takes place at a distance through all bodies, conductors and non-conductors; and hence no coating that be put upon the wire will prevent the formation of induced currents.

I think it not improbable, since the earth has been made to act the part of the return conductor, that some means will be discovered for insulating the single wire beneath the surface of the earth; the difficulty in effecting this is by no means as great as that of insulating two wires, and preventing the current striking across from one to the other. A wire buried in the earth would be protected in most cases from the effect of a direct discharge; but the inductive influence would still be exerted, though perhaps in a less degree.

The wires of the telegraph are too small and too few in number to affect, as some have supposed, the electrical condition of the atmosphere, by equalizing the quantity of the fluid in different places, and thus producing a less changeable state of the weather. The feeble currents of electricity which must be constantly passing along the wires of a long line, may, however, with proper study, be the means of discovering many interesting facts relative to the electrical state of the air over different regions.

REGISTER OF NEW PATENTS.

WAGON COVERS AND WRAPPERS.

HENRY HENSON, of Hampstead, in the county of Middlesex, gentleman, for "a new fabric, suitable for goods' wrappers, wagon-covers, and other like purposes; and certain processes employed in the manufacture of the same."—Granted November 5, 1846; Enrolled May 5, 1847.

This invention relates to the manufacture of two descriptions of fabrics; one suitable for covering wagons, coaches, or other vehicles, &c., and the other for covering light goods, which are not generally exposed to the weather, and for similar purposes. The base of the first fabric is hempen thread; with which is interwoven, when the fabric is being made in the loom, copper wires, or galvanized iron wires covered with thread (but uncovered may be used, if preferred), or thin strips of cane; the object being to produce a fabric which shall not be liable to be rent or torn. The wires or strips of cane may be inserted at from one to six inches apart, according to the strength required, and the thickness of the wires or strips; and they may form part of either the warp or weft. For ordinary fabrics, No. 28 wire will be found suitable, and inserted at two inches apart. The fabric is immersed in a vat, filled with tanning liquor, of 1½ cwt. of good oak bark to one hundred gallons of liquor; the fabric must be so proportioned to the quantity of the liquor, that for every yard there shall be about two gallons of tanning liquor, and to remain in the liquor for about fifty hours, and kept at a temperature of 150°; it is then removed from the vat, and hung up to dry. If the fabric be required to possess the quality of leather in a greater degree than can be given to it by the above process, this may be effected by subsequently immersing it, for about ten hours, in a weak solution of gelatine or albumen, and repeating this operation two or three times, according to the effect desired to be produced. Instead of the above process of tanning, the well-known processes of tanning by exhaustion, or by hydraulic pressure, may be employed. The fabric is now waterproofed, by first saturating it with a composition called by the patentee No. 1, and, when that has become dry, coating it with another composition termed No. 2. The first composition is formed of one gallon of turpentine, one pound of tallow, and one pound of bees' wax; and the second is composed of two quarts of raw linseed oil, one quart of boiled linseed oil (rendered drying by the addition of litharge), one quart of Stockholm tar, and twenty ounces of lamp-black or ground charcoal. The fabric is placed upon a hollow iron table or chest, heated by the admission of steam into it, and the compositions are applied by means

of a spatula or brush; the first composition being forced into and through the fabric, and the second laid on evenly and smoothly.

The second description of fabric is made by pasting, cementing, or otherwise uniting a sheet of paper to a sheet of calico or similar textile fabric, which has been previously waterproofed and japanned.

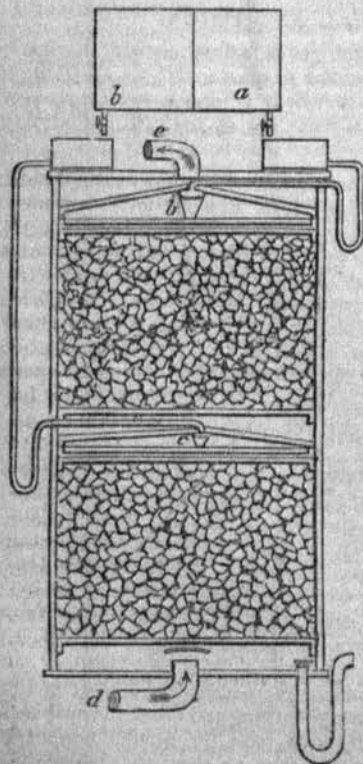
MANUFACTURE OF GAS.

GEORGE LOWE, of Finsbury-circus, Middlesex, engineer, for "*Improvements in the manufacture of and in burning gas, and in the manufacture of fuel.*"—Granted Oct. 8, 1846; Enrolled April 8, 1847.

The improvements relate, first, in preparing peat in combination with resin, pitch, oil, fat, or other hydro-carbonaceous matter, and in making gas therefrom; secondly, an apparatus for purifying gas; thirdly, in making gas from coal and other matters, by introducing steam, highly heated, into the retorts used; fourthly, in improvements in Argand gas-burners, whereby the gallery or apparatus carrying the chimney is made to rise and fall on a screw, so as to adjust the admission of the air to the flame; and, fifthly, in manufacturing fuel from peat, by causing dry blocks of peat to be saturated with pitch or other hydro-carbonaceous matters.

The first part of the invention is for saturating blocks of peat with resin, pitch, fat, oil, or other hydro-carbonaceous matters. The peat is cut into blocks, and well dried, and then saturated by piling the peat in a square cast iron boiler, about 18 inches deep, to within a few inches of the top; then melted pitch, resin, tar, or combinations thereof, or other cheap hydro-carbonaceous matter, in a highly-heated state, is allowed to flow into the boiler, and heat is then applied; by such means, the hydro-carbonaceous matter penetrates the blocks, and causes them to be well saturated, the time of such process depending on the character of the peat and the sizes of the dry blocks, but generally about an hour is sufficient. When the blocks are saturated, the remainder of the fluid matter is allowed to run off, and the blocks are removed, and a fresh quantity put into the boiler, and the saturated blocks are placed on edge on open shelves to drain, and afterwards made into gas, by being placed into retorts, in the same manner as coal. The patentee prefers to saturate the dry blocks of peat by placing them within a vessel, such as is now used for saturated wood by the aid of vacuum and pressure. When using tar as the hydro-carbonaceous matter, it is advantageous to combine therewith from five to ten per cent. of quicklime in the state of powder.

The second improvement relates to an apparatus for purifying gas. The annexed engraving is a section of the apparatus, made in two



coal, prepared peat, or other matter rich in carbon. Steam from a steam-boiler or vessel passes through pipes highly heated, in a like

compartments, weak ammoniacal liquor to be used in the lower one, and water or water acidulated with sulphuric or muriatic acid in the other. These two compartments are each nearly filled with lumps of coke, as has before been done in constructing what is called the scrubber; and the improvements consist of the means of distributing the purifying fluid used. *a* is a tank of water or other purifying liquid; *b*, a tank for weak ammoniacal liquid; *b'*, *c*, are two perforated pipes on axes, the perforations on either side of the axis of each pipe being on opposite sides, so that the flow of fluid in streams will cause the tubes to revolve on their axes and distribute the fluid equally on the coke; the gas rising upwards from its pipe of introduction at *d*, passes off, partially purified from ammonia, by the pipe *e*; and it is the use of revolving pipes, *b'*, *c*, which constitutes the novelty of this arrangement of apparatus.

The third part of the invention consists in applying steam, highly heated (after it leaves the boiler or generator), into the retorts used when making gas from

manner to that commonly resorted to for obtaining hot blast in the manufacture of iron, which highly-heated steam is conducted by a pipe into that part of a gas retort most distant from where the gas passes off from the retort. The steam is generated under a pressure about that of the gas, and it flows into the retort freely at the commencement of gas making, after charging the retort, and it is stopped after the most carbonaceous matters have been driven off from the coal or other matter used.

The fourth part of the invention relates to improvements in Argand gas burners, by so arranging the gallery for carrying the chimney for directing the air to the external surface of the flame, that it may rise and fall, and be fixed at the required position by a screw or other means, and thus allow of a nice adjustment of the admission of air to the flame.

The fifth part of the invention consists of treating blocks of dry peat in the same manner as that described under the first part of the invention for gas making.

STEAM HAMMER.

JOHN CONDIE, of Glasgow, engineer, for "*Improvements in machinery used in manufacturing malleable iron.*"—Granted Oct. 15, 1846; Enrolled April 15, 1847.

The improvements relate, first, to the arranging or constructing steam hammers, that the steam cylinders have the hammer faces applied thereto and move therewith; and, secondly, to the introduction of malleable iron tubes into anvils and hammer and squeezer faces.

Fig. 1 is a front elevation of the hammer and steam apparatus;

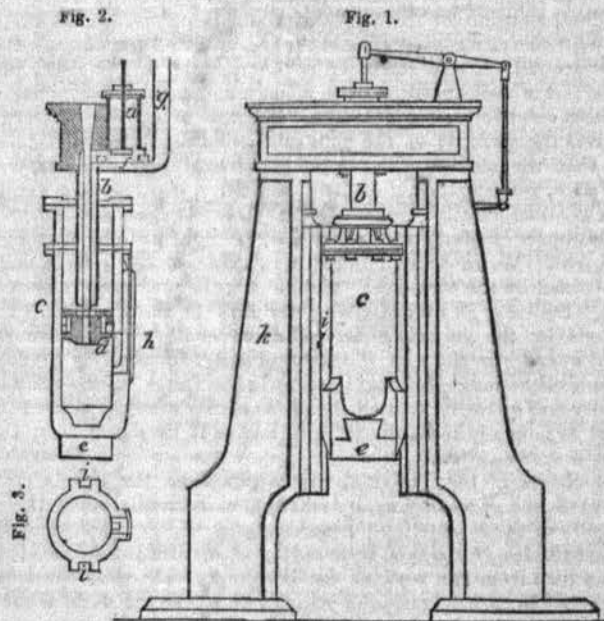


fig. 2 a vertical section, taken at right angles to fig. 1; and fig. 3 a plan of the cylinder. The steam is admitted through the valve *a* and tube *b*, which encases the piston rod, into the steam cylinder *c*, and presses on the piston *d* (which is fixed) and the cylinder top, and raises the cylinder, which is made moveable, together with the hammer *e*, attached thereto, until the steam valve *a* closes, and cuts off the supply of steam, and at the same time opens the outlet port *f*, to allow the steam to escape from the cylinder through the pipe *g* into the atmosphere; consequently, the hammer will then fall by its weight, and when the steam is again admitted the same operation is repeated. Near the bottom of the cylinder, there is a port, or ports, *h*, to allow the air under the piston to escape while the cylinder and hammer are being raised, and also the air to return when the hammer is falling. When the hammer is required to strike with more force than its weight alone, the throttle valve is fully opened, which causes the air port *h* to pass the piston and compress the air under the latter, by which additional recoil will be given to the fall of the hammer. The cylinder is guided by guides *i*, working in grooves attached to the vertical framing *k*.

The hammer may also be worked without the air port *h*, at the bottom of the cylinder; in such case, the cylinder is made longer, and the air under the piston is compressed, as the hammer is raised, until its density is about half that of the steam. When the steam is

allowed to escape by this plan, the compressed air gives additional force to the blow of the hammer.

FIGURED SURFACES.

ARTHUR MILLWARD, of Birmingham, in the county of Warwick, gentleman, for "*certain Improvements in producing figured surfaces, sunken and in relief.*"—Granted October 15, 1846; Enrolled April 15, 1847. [Reported in *Newton's London Journal.*]

This invention is divided into eight parts; it consists, firstly, in the following method of producing sunken designs on metallic surfaces:—The design is painted, drawn, or otherwise depicted on the metallic surface to be ornamented, or it is imprinted thereon by stencilling or transferring; a thin coat of gold, silver, copper, or other metal is deposited by voltaic electricity or other means on all parts of the surface, except those which are covered by the design, or are, to use the patentee's words, "stopped out;" then the colouring or other materials employed in the stopping out are cleared away, and the surface is connected with the negative pole of a voltaic battery, or electro-magnetic machine, in which the solution employed is of such a nature as to act only on the ground-plate, whereby all those parts of the plate which were covered by the stopping out, but are now laid bare, may be decomposed or eroded to any extent required. Instead of a voltaic battery or electro-magnetic machine being employed, the metallic surface may be immersed in any acid or alkaline or other saline solution, capable of acting on the exposed portions of the surface, but not on the precipitated metal. The sunken design may be intersected in different parts by cross lines in relief, so as to present the appearance of "cross-hatching," by inserting such lines with a pencil dipped in varnish, after the plate has been cleared of the stopping out, and before it is subjected to the decomposing or eroding action.

The second improvement consists in producing sunken designs on metallic surfaces, by first covering the whole of the surface, in the manner above mentioned, with a coat of any suitable metal, and varnishing the same; next scraping the design in the varnish; and then subjecting the surface to the decomposing or eroding process, whereby the metal left exposed by the scraping out is removed and the sunken design produced.

The third improvement consists in producing figures in relief on metallic surfaces, by first coating the same with any suitable metal, and painting, drawing, or otherwise depicting the required design thereon, or imprinting the design upon it by stencilling or transferring; the design is then intersected by indented lines and cross lines, after the manner of line engraving (the whole of the colour or other material used in laying on the design being cleared away from such lines); and, after this, all those parts of the deposited metal which are left exposed are removed by the eroding process, and the lines of the design only left standing in relief from the ground-plate.

The fourth improvement consists in the following method of producing designs in relief:—The surface or ground-plate is varnished all over, and at certain parts the varnish is scraped away to form the required design; upon the exposed parts a coat of any suitable metal is deposited, and the remainder of the varnish is then removed from the plate; after which, the unprotected parts of the ground-plate are removed to the desired extent by the decomposing or eroding process.

The fifth part of the invention relates to the production, in metals, of designs which partake of the character of being both sunken and in relief, and are commonly termed "pierced work." To the ground-plate a thin coat of any suitable metal is applied, by electro-deposition or otherwise, and the design is painted thereon; all the parts except those beneath the design are then subjected to the decomposing process, until the said parts (both ground-plate and coating) are completely eaten through. The colour or other material used in laying on the design may be afterwards cleared away.

The sixth part of the invention also relates to "pierced work." A metal-plate, on which a raised design has been stamped out, is covered all over with any suitable metal by electro-deposition; then, by means of a scraper or other tool, the deposited metal is removed from those parts which are to be pierced through; and, after this, the exposed portions of the plate are decomposed or eroded. The same object may be effected by cutting through the metal deposited on the front of the plate all round the design, when so much of the deposited metal as covered the design drops out; and all the parts of the plate from which the deposited metal has been removed are then dissolved or decomposed by the means before mentioned. Any suitable varnish may be used instead of a coat of metal as the stopping-out material in the above processes.

The seventh part of the invention relates to the mattenning or deadening of articles with plain or figured surfaces, which have been

manufactured by the processes of stamping, embossing, or casting. The portions of the surface required to be mattenning or deadened are covered with varnish or other suitable medium, and the remaining portions of the article are coated with any suitable metal by electric deposition; the varnish or other medium being then cleared away, the parts of the plate left unprotected are subjected to the decomposing process. A similar effect may be produced by at once stopping out all the parts but those required to be mattenning or deadened, and submitting the plate to the decomposing or eroding process.

The last part of the intervention relates to the production of engraved surfaces, sunken and in relief, from which impressions may be taken on paper, cloth, or other suitable material, by the ordinary modes of printing or embossing. If the design is to be sunken, it is painted or otherwise depicted on a plate or metallic surface; a thin coat of any suitable metal is next deposited upon the uncovered parts; then the colour or other material employed in forming the design is cleared away, and the parts of the plate thus left uncovered are decomposed or eroded to the required depth. When the design is required to be in relief, the plate first receives a coat of any suitable metal; the design is then painted thereon; and those portions of the deposited metal which are not covered by the design are decomposed, leaving the design standing out in strong and clear relief.

The patentee claims, Firstly,—the producing of sunken figured surfaces by the combination of painting, drawing, transferring, stencilling, or other known processes of delineating objects with the direct action of voltaic electricity, in the manner above described. Secondly,—the producing of sunken figured surfaces by the employment of a combination of metallic precipitates or deposits with the direct action of voltaic electricity, as above described. Thirdly,—the producing of figured surfaces in relief by the combination of metallic deposits with painting, drawing, transferring, stencilling, or other known processes of delineating objects, and with or without the addition of the process of line-indenting or engraving, as above described. Fourthly,—the producing of figured surfaces in relief by the combination of the processes of varnishing and scraping out with the metallic deposits, and the direct action of voltaic electricity, or acid or alkaline or other saline solution, as above described. Fifthly, and Sixthly,—the producing of pierced work by all or any of the processes described under the fifth and sixth heads of this invention. Seventhly,—the process of mattenning or deadening plain and figured surfaces, above described. Eighthly,—the production of figured surfaces, sunken or in relief, for the purpose of printing from or embossing, by the processes described under the last head of the invention.

SHEET METAL AND PAINT.

BARON CHARLES WETTERSTEDT, of Rhodeswell-road, Limehouse, for "*Improvements in the manufacture of sheet metal for sheathing and other purposes, in preventing the corrosion of metal, and in preserving wood and other materials.*"—Granted Nov. 3, 1846; Enrolled May 3, 1847.

This invention consists, first, of a mode of manufacturing lead into sheets for various purposes; secondly, of a mode of manufacturing copper into sheets, and in combining metals to be afterwards rolled into sheets for sheathing and for other purposes; and, thirdly, of manufacturing composition or paints for preventing corrosion of metal and for preserving wood and other materials.

First, for manufacturing lead into sheets, there is to be added to the lead, when in a melted state, a quantity of regulus of antimony, in the proportion of from one to two parts in weight to 100 parts of lead; the same is to be well stirred and the impurities skimmed off, when the mixture may be poured out and rolled into sheets in the same manner as lead.

The second part of the invention is the manufacturing copper into sheets. When the copper is in the refining furnace and just before it is to be run out according to the ordinary process, there is added a quantity of regulus of antimony in the proportion of 1 lb. to about 200 lb. of copper; and at the same time about 2 lb. to 3 lb. of calcined soda, heated to such a degree as to be just previous to melting, and after stirring the whole of this mass together and skimming the surface, it may be run into moulds in the ordinary manner and afterwards rolled.

Another part of the invention is for combining copper and other metals to be rolled into sheets for sheathing and other purposes. Two furnaces are to be used, side by side, one for refined copper, kept ready to be run out into the moulds; and in the other yellow metal (Muntz's patent metal). Take one part of copper and four or five parts of yellow metal, and pour them into a mould of cast or wrought iron coated with clay and sand; and heat the same to a red heat, when

the whole mass will be in a fit state for rolling. Instead of yellow metal, brass may be employed. And the same process may be employed with lead and tin, the lead being first poured out, and then the tin, the proportion being four or five parts of lead and one of tin, or tin and lead combined. This sheet metal will be very suitable for water cisterns, &c.

The third part of the invention is for preventing the corrosion of metals, and preserving wood and other materials by combining metals together, and then applying them as a paint on the surfaces of the metal or wood, which paint consists of regulus of antimony and copper, mixed together in the proportion of one part of antimony to two or three of copper; to be well mixed and melted together, and run out into water, and afterwards dried by a gentle heat. Then about two parts of oxide of copper is added, and the whole ground together and moistened during grinding with naphtha, sufficient to bring it into a thick pasty state. A solution, composed of tar and naphtha in equal parts, is then made, and mixed with the metallic compositions, in sufficient quantity to bring the composition into a suitable state to be employed as a paint.

When preparing paints in which zinc or lead is employed, antimony in the proportion of $1\frac{1}{2}$ part of antimony to 1 part of zinc or lead is to be used; and when tin is used, the proportion is two of antimony to one of tin. These materials are to be first melted together, then poured into water, and ground as before described, leaving out the oxide of copper, and when ground they may be brought into the proper state to be employed as a paint, by mixing with either a sufficient quantity of oil and turpentine and suitable drying ingredients, or they may be mixed with the naphtha and tar as before described.

Another composition for the same purpose is prepared as follows:—Take 30 lb. of tar, 30 lb. of pitch, 20 lb. of dried soot, and 4 lb. of tallow or sperm oil, and melt the whole together, adding naphtha to it in the proper quantities, so as to bring it into the suitable consistency required for the purposes to which it is to be applied.

Another part of the invention for the prevention of the corrosion of metals, is by immersing sheets of copper or zinc, and also copper and zinc nails, in a solution of muriatic acid and other materials in the following proportions:—Take about 60 lb. of muriatic acid of commerce, about 10 lb. of oxide or old copper, and about 3 lb. of regulus of antimony, and mix the whole well together, and place the sheets or nails therein, and allow them to remain for two or three days—the solution being at a temperature not less than 70° Fah.

SCHINKEL'S REMARKS ON ART, ART-CULTURE, AND ART-LIFE.

By DR. G. F. WAAGEN.*

Having been called upon by many artists and art-friends to publish my discourse, uttered on this year's anniversary of Schinkel's birthday, I have undertaken my task the more eagerly, as his remarks possess not only a subjective value, derived as they are from such a man, but may also have a great objective utility for art-pupils, who earnestly desire to strengthen themselves in sentiment and activity.

That gloomy—yet, after all, elating and fine feeling, of celebrating the memory of a noble mind, which that unavoidable transition to higher existence (called, perhaps improperly, death) has deprived us of,—pervades, I am sure, the breasts of all in this solemn meeting. A nature so rich as that of Schinkel, presents always new aspects for consideration. I intend, therefore, to fix attention to some observations, which have been found amongst the papers of the departed—albeit merely detached leaves; still, most fit to show his character as an artist in a very clear light. I hardly think it necessary to observe, that some slight inaccuracies of diction must not be taken into account; as, in the first place, the handling of the pen may not be considered the very province of the forming artist (*Bildenden Künstler*). What these remarks may want in this respect, a certain touch of genius will greatly recompense.

Amongst one of the most distinguishing qualities of Schinkel, by which his great exertion in art has been caused—is his great moral strength, his healthful and spirited vivacity, his rigid, unrelaxed tendency to progress; on which account, nothing seemed so averse from him as the reposing on one's laurels, the so much wanted *otium cum dignitate*. How much he knew that, how great were his self-imposed duties on that account, his own words will best illustrate. "The conditions of a perfect existence (*Zustände*) are real liveliness and stirringness; phlegma, be it bodily or mindly, is a sinful situation for him who lives in a civilised nation—an animal for them who live in times of barbarism! Only that artwork, which has entailed the spending of noble forces, and in which appears the highest tendency of man—a noble sacrifice of noble powers—imparts true interest and edification. Wherever it is seen that a master has taken things too

easily, that he has not striven after something extraordinary and novel, but has abandoned himself to routine and stale and stable art-rules—even if he has succeeded in displaying all known form-beauties—he will not overcome, it appears to me, the ennui of the beholder; and such works, however superior in many respects to those of inferior minds, are nevertheless unworthy of him who could have achieved more. In the physical as well as art world, we are only then really living when something novel is created; and whenever we go too securely on trodden paths, our exertions become ambiguous, as we then have perfect knowledge of what is to be done—do, therefore, something which already exists: handle something second-hand, as it were—and repeat repetitions. 'This, surely, is already a half-dead vitality.'* Wherever we are yet uncertain, but feel the impulse towards, and the presentiment of, something beautiful, which is to be produced—there, therefore, where we seek, we are really alive and vivified. From these reflections, may be explained the often apprehensive, anxious, and even humble temper of the greatest talents on earth—compared with the bouncing, over-bearing, and self-sufficient contentment of the successful and purse-proud cobbler and handicraft-man."

These forcible expressions of Schinkel are not only most characteristic of the whole art-mind of the departed—but, perhaps, never before has that trepidation and hesitation, those pangs of parturition, felt in the holy privacy of the man of genius—who constantly feels his aim is infinite, merely attained at by approximation—been so truly and concisely expressed as here. If it has been repeatedly remarked, that one of

the chief characteristics of Schinkel's art-genius consisted in the combination of the manifold and most pregnant practical creations, together with the unrelaxed study of the general and eternal laws of art—viz., theory—the following extract, derived from an unpublished work of the great architect, will show how early he felt what others never do.

"I perceived, when I began my architectural apprenticeship, a great treasure of forms, which, for scores of centuries past, have guided nations in the various phases of their culture, in the execution of their buildings and structures. But I saw, at the same time, that our use of this treasure was arbitrary, and that what produced a most pleasant effect in its primitive usage, was quite inappropriate in its present application to structures of this age. Especially clear became the conviction to me, that in the *arbitrariness* of form-giving—the real cause of want of character and style in so many of our modern structures is to be sought for. It became a vital question with me to arrive at the bottom of these anomalies; but the deeper I penetrated on this topic, the larger and more comprehensive it appeared to me. At first, I fell into the error of pure, fundamental abstraction, and developed the whole idea of any given structure from its nearest trivial object and scope, and the three laws of construction. In following this course, dry and stiff works will result, wanting in freedom, and excluding the 'two grand elements of architecture—the historical and poetical.' I further inquired in how far the mere rational principle be sufficient for fixing the mere mechanical and trivial basis of an edifice, and how much there be required of the higher influence of the historical and poetical to elevate it to the conception of an art-work. It became clear to me, that I had arrived at that point in architecture, where the real element of art is to be placed, which, in every other respect, 'was and would be but a trade with a scientific basis!' At the same time, it became clear to me, that in this stage of thought (here, as in any other art), the dogmas of a doctrine became difficult to be uttered, and were perhaps reducible to a culture of feeling and intuition—qualities of the mind which comprehend, in architecture, a very wide compass, and require to be much and most variedly developed, if their products are to yield great results.† It appears to me necessary to ascertain properly the different spheres in which the feelings and intuition of the architect are to be developed, which will also enable us properly to survey the extent of this art-branch.

"We have, therefore, to consider, first, what are the desiderata of our time in architecture; secondly, a retrospect on previous periods will show what has been then used for similar purposes, and what of that (considered in its perfection) may be useful and adequate now. Next, the modifications of approved expedients are to be properly weighed. It is, however, chiefly necessary, that (fourth) we inquire how imagination has to act in the assimilation and modification of these expedients—how, thence, the new product is to be treated in form and essence. This, however, is to be done thus, that it may still possess some historical basis, and that the conception of the new may arise without taking away the impression of an architectural style—by which doing, the combined feelings of style and something primitive, and even ingenious, will arise in the beholder."

From this it is to be seen what general path Schinkel has traced out for the builder of present times. But for complete success, he has pointed to a series of abstract intuitions—from which the principles according to which the artist has to act, are to be deduced. These intuitions are the hidden point of crystallisation (*punctum saliens*) of every mind destined for, or tending after, greatness.

* It may be said, that such remarks are unprofitable, as we cannot all profit by them, and achieve so high a pitch of perfection. In reality, they are not so. Every one may reach as high as he can. "It is undoubtedly superiority to know one's own inferiority," and to worthily co-ordinate ourselves to such. It is not honest, unpretending men who have ever injured art and mankind—but the conceited, would-be, and pretending.—[Dr. Waagen.]

† May appear still more discouraging than the previous remarks. Our despondency, however, would not make things different from what they are. It is once in a hundred years or so, that great talents arise, be it in architecture, or otherwise. Fate, like other things, will be led at times, but never driven.—[Dr. Waagen.]

* Einige Aeusserrungen K. T. Schinkel's über Leben, Kunst und Bildung. Von Dr. G. F. Waagen. Berlin: Gropius, 1846, 8vo.

On the other hand, a most detailed study of the architectonic forms of all times and ages, had brought Schinkel to the idea, that the intuition of true principles of art-style had never started so clearly, harmonically, and fairly as with the Greeks—for whom and with whom our departed friend had formed a connection of the most intimate sympathy. And thus, in another of his fragments, he says—"The real study, especially an assiduous exercise of imagination on the terrain of classic art, will alone bring harmony in the general culture of men, belonging to these latter days." But it was in many other respects that Grecian antiquity attracted him so forcibly. It was one of the most vivid ideas of Schinkel, to think that "the highest and most general signification (*Be-deutung*) of fine art was the ethic education and ennobling of men by the beautiful." But this, certainly, has never and nowhere come into practice so extensively—nowhere been so extensively resorted to—as wherever Hellenic existence has taken root in the world. And thence Schinkel, speaking of *Herculaneum* and *Pompeii*, says—"In this buried little town, not even the meanest person's house was without art; every one was so far cultivated, as to surround himself with art-culture,† from which thought, ideas, precept spoke to him—and thence was developed an immense treasure and great delicacy of thought and sentiment, which, perhaps, constitutes the very principle of culture (*cultur zustandes*)."—Nay it may be said, that Schinkel's whole life and his tendency in art, were so much identified with the noblest ideas which Hellenic civilisation presented—as well as its various forms of pure and beauteous humanity, that both cannot be better expressed than by the Greek term, *Kallokagathia*, which means the innermost (natural) combination of the beautiful and good.

Notwithstanding this enthusiasm for Grecian art, Schinkel, in his capacity of practical architect, was far from imitating it servilely and in contradiction to the wants of our times, which is evinced in many of his splendid buildings. Alike, this made him not un-susceptible of the particular grandeur and the wonderful mystery of Gothic architecture, as his restoration of *Cologne Cathedral*, several of his oil paintings—nay, even some of his exquisite designs of churches, fully demonstrate.

It cannot be doubted, in fine, that to a mind like that of Schinkel, the immense disparity of the public taste in our times, and those of Grecian antiquity, should have escaped. He says—"There are few persons who can elevate themselves in the contemplation of art-works, especially buildings, to the standard of general culture or general civilisation. In the main, they find only that beautiful and praiseworthy, which is desirable in their own individual circumstances;—the common, the every-day work, with a certain degree of completion and nicety, is all they ever require. The novel, grand, and uncommon hardly ever pleases the great mass; and if it does not suit their most obvious convenience, it will meet with much opposition and obloquy." Unhappy he—who, has the genius and tendency for art, is obliged to serve such paltry purposes; into which, however, nearly the whole of our architectural and structural endeavours are now resolving.

J. L.—Y.

† We think that some of these sayings ought to be inscribed in brass and marble on some of our public buildings.—[*Waagen*.]
‡ The compounds of the German word, "*Culture*," are very difficult to be rendered in English.—[*Transl.*]

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

June 14.—AMBROSE POYNTER, Esq. V.P. in the chair.

A communication was read from A. H. LAYARD, Esq., relative to further Discoveries made by him at *Nimroud*; particularly as to the fact of the employment of colour by the ancient Assyrians in the embellishment of their architecture and sculpture; describing the mode of construction adopted, and stating that it had been satisfactorily ascertained that the buildings recently brought to light are of various epochs; and expressing an opinion that some of those at *Nimroud* are of much more remote antiquity than those at *Khor-sabad*—and probably of the age of *Ninus* or *Semiramis*.

"On the Geometric System applied by the Mediaeval Architects to the proportions of their Ecclesiastical Structures." By R. D. CHANTRELL, Esq.

The chief object of the paper was to prove that in all the mediaeval structures a general principle of the most perfect and beautiful proportion pervades the design, and may be recognized by the scientific observer. This system must be adopted by the modern architect in order to produce the same successful results. That some general principle of composition had been adopted by the mediaeval architects is an opinion that has been entertained by various individuals for many years past; and attempts have been made by *Kerrick*, *Essex*, *Browne*, and others to develop it. Their endeavours have been attended with various degrees of success; but according to the author of the paper no one but himself has succeeded in discovering the true principle capable of uniform application. Mr. Chantrell exhibited a number of plans and other diagrams in elucidation of his theory; and without which it would be impracticable to convey an adequate idea of the system.

Models of a new kind of brick invented by Mr. Merrell, of Woodbridge, were exhibited and explained. The bricks are so shaped as to form internal channels for the passage of air—and consequently produce a thorough ventilation of the wall.

INSTITUTION OF CIVIL ENGINEERS.

June 1.—Sir J. RENNIE, President, in the Chair.

"An Account of the iron barque *JOSEPHINE*, of *Liverpool*." By Capt. MASTERS, who commanded her in the voyages she has made.

The paper read was a plain and somewhat dry specification of the construction of the vessel, which will, however, when printed *in extenso* in the minutes of proceedings, be extremely useful. The main dimensions of the barque *Josephine* are—Length, over all, 99 ft. 3 in.; extreme breadth, 24 ft. 6 in.; depth of hold, 9 ft. 9 in.; register tonnage, 168 tons; by old measurement, 221 tons. She was of a peculiar build, differing from almost any other merchant-ship, being intended for service in the Mexican trade, and calculated to cross the bar of *Tampico*, and other impediments. She was entirely of iron, even to the bulwarks; and as she lay low in the water, drawing 9 ft. aft, and 8 ft. 8 in. forward, her ports were hung on hinges forward, so that they should act as valves, and allow the water to escape from the deck, and yet shut of themselves when she heeled over deep on her side. Her general rate of sailing was from 11½ to 12 knots per hour; she was very buoyant and very dry, rising well to the sea. There was great capacity for stowing the cargo, owing to the absence of large projecting timbers. She was somewhat damp forward and aft, but was very dry in the main hold. There was not found to be any difference in the health of the crew from that of wooden vessels; she was a little cooler than other ships, owing to her being so deep in the water, and the thin material did not retain the heat like wood.

Iron ships have generally been found to get very foul: the *Josephine* was, however, paid with various compositions as experiments. That which succeeded best was—1 barrel of varnish, 2½ cwt. of best tallow, 40 lb. black lead, 7 lb. brimstone, and 70 lb. arsenic. This being applied hot, the iron having been previously warmed and paid with boiled linseed oil, appeared to have prevented foulness, as after her voyages there was little weed or grass, and scarcely any barnacles; but very slight oxidation took place, and that only where the composition had been rubbed off.

They were as much annoyed by rats as in a timber ship, nor could they be destroyed by any of the means adopted. The principal feature of the paper was that which treated of the local attraction of the compass, which can scarcely be noticed in an abridged form. It appeared that the ship was on an even keel, and perfectly upright, the compass acted correctly; but in proportion to the listing over, so was the derangement of the magnet, the local attraction being changed by the side frames and deck-beams falling into new positions. This caused great variation in the ship's course, and it led to a conjecture whether this may not have been the cause of the loss of the *Great Britain*—as if her compasses were acted upon as much as those of the *Josephine*, a deviation of 6½ miles from her course might easily have occurred. Capt. Masters suggested the hanging the binnacles complete in gimbles like the compass, in order to their always remaining vertical, and also in adjusting the compasses that they should be tried in every position, a table of variation being made out for every degree of listing over. The paper was illustrated by drawings of the vessel and of her rigging, which possessed peculiarities, and also by several tables for the correction of the compasses.

June 8.—The following papers were read:—"On the Expansive Action of Steam." By Mr. J. M. HEPPEL, Grad. Inst. C.E.

The object of the paper was to deduce a more exact formula than those now in use for the dynamical effect developed by steam in expanding from one pressure to another. The usual method of computing this effect neglects the influence of the variation of temperature, which always accompanies change of density, and which has been shown to modify considerably the corresponding pressure. M. de Pambour, however, has, by combining *Guy Lussac's* formula for the relation between temperature and density under uniform pressure, with that of *Boyle* for the relation between density and pressure under uniform temperature, deduced a formula containing the density, pressure, and temperature, from which any two being given, the third may be deduced.

What was further done in Mr. Heppel's paper, was to combine this formula with one by Mr. Scott Russell, expressing the relation between the pressure and temperature, and by this means to eliminate the latter, and obtain a formula containing only the pressure and density. From this formula another was easily obtained, showing the total dynamical action developed during expansion from one pressure to another, and the results were given in a tabular form, exhibiting—

1. The pressure in lbs. per square inch.
2. The relative volume, or ratio of the volume of steam, to that of the water which produced it.
3. The dynamical effect before expansion, or the number of lbs. raised one inch by the evaporation of each cubic inch of water.
4. The dynamical effect during expansion, or the number of lbs. raised one inch by the steam produced from one cubic inch of water in expanding from a pressure of 100 lb. per square inch to the particular corresponding pressure. The dynamical effect in expanding from any one pressure to any other, must

be clearly expressed by the difference of the corresponding numbers in this column.

Part of the remainder of the paper was devoted to showing, that whilst the performance of engines could not possibly be expected to exceed the results ascertained as above, it should not fall far short of them in the case of engines of good construction. In conclusion, a simple method was suggested of ascertaining the magnitude of all the forces in action during the working of the Cornish engine, independently of the indicator.

In the course of the paper, the fallacy of the theory of what had been termed the "percussive action" of steam was ably exposed; and although, from the paper being full of mathematical formula, it was not well adapted for being read at a public meeting, it evidently possessed great merit as an investigation of an important subject.

"On the Expansive Action of Steam." By Mr. TATE, mathematical master of the Training College, Battersea.

The object of this paper was to demonstrate and apply a formula some time since discovered by the author, expressing the law of the expansion of steam, and at the same time to establish certain general equations relative to the work of steam, applicable to all formulæ professing to give the law of volume and pressure. It also examined and corrected Pole's formula, which, although a decided improvement upon Pambour's, was stated to be not sufficiently accurate for pressures above 70 lb., or below 16 lb.

M. PIANGET exhibited in the library, after the meeting, specimens of his improvements in producing ornamental metal surfaces, formed by the deposition of metals during the electrotype process, which is conducted in a peculiar manner, with mixtures adapted to the effect desired to be attained. The form also of the bath is peculiar, and when the plate is taken out of it, and off the model, it exhibits a burnished polish, or a dead appearance, according to the preparation used. The metal thus produced is stated to be of a much better description than metals which have not undergone such process, as it is more flexible, and is capable of withstanding the action of heat without destroying the form or the copper, and the surface will not tarnish when exposed to the air. Portions of any pattern can also be silvered by a similar process; and the general expense is about one-third of that of engraving or chasing, while the boldest or most minute patterns can be equally well produced.

June 15.—"On the Law which Governs the Discharge of Elastic Fluids under Pressure, through short Tubes and Orifices." By W. FROUDE, M. Inst. C.E.

The law proposed was a modification of that which has been usually assumed—viz.: a simple application of that which holds good with respect to non-elastic fluids; this law is, generally, that the velocity of issue is directly as the square root of the pressure, and inversely as the square root of the density; but this law neglects wholly the reaction that must arise from the expansion necessarily taking place in the course of issue. The nature of the action was illustrated by the following example:—If a balance be supposed, with an equal weight in each scale, one of the weights being a spiral spring, like that of a spring balance compressed lengthwise with its axis vertical, and held in a state of compression by a cord. Now let the cord be suddenly reversed, so that the spring is enabled to extend itself vertically; the scale in which it stands will obviously be depressed, the spring reacting on it as it expands upwards, and continuing to press till wholly relaxed; or if the scale in which it stands were ascending by a preponderance given to the other scale, the rate of ascent would be in the same way retarded. The amount of the retardation would depend on the strength and the weight of the spring, and on the length to which it would extend itself when released. Now in the discharge of an elastic fluid, there is an action, strictly analogous, operating continuously, however, instead of *per saltum*, the strength and weight of the spring being represented by the elasticity and density of the fluid, and the length to which it would extend itself by the degree of expansion, in the course of issue. The reduction in quantity of discharge, due to the action, was to be measured by the velocity imparted by expansion, to each particle of the elastic fluid in course of issue, the velocity of each particle after expansion, would be its velocity before expansion, multiplied into the rate of expansion, and the primary force must be subdivided in generating each additional unit of velocity, so that the portion applicable to the generation of velocity before expansion, would be the whole force divided by the rate of expansion; thus, the velocity before expansion would be divided by the square root of that rate. For instance, an elastic fluid expanding four times in course of issue, would be discharged with only half the velocity of a non-elastic fluid, under the same circumstances of pressure and density. This modification was shown to fulfil the general dynamical law "that a given force, acting for a given time, will produce a given momentum, whatever be the weight of the mass acted upon." This seemed to be the essence of the law for non-elastic fluids, but it was disregarded by the unmodified application of that law to elastic fluids, in which there would be a great accession of velocity, of particles issuing under a given pressure, without any reduction of quantity discharged in a given time; if, however, the quantity be reduced as proposed, in the ratio of the square root of the density, and the velocity be accelerated in the same ratio—the final momentum would be the true equivalent of the pressure. This, in its practical application, explained what was inexplicable by the ordinary theory.

The difficulty experienced from the back pressure of the waste steam in locomotive engines was exhibited, showing, that at 60 miles per

hour, this would be at the least equivalent to 8 lb. per inch throughout the stroke, thus showing a loss of nearly 50 h.p. As applied to the case of air, discharged into an exhausted receiver, the result was highly curious. The rate of discharge, instead of increasing throughout as the degree of vacuum was increased, would be maximum at 15 inches of vacuum, although nearly uniform for many inches above and below that point; it would, however, progressively decrease above that point, because the expansion would increase in a higher ratio than the pressure, and ultimately, at the point of perfect vacuum, it would be at a minimum (indeed stationary, were air perfectly elastic), because at that point the expansion would be infinite, but the pressure only finite—viz.: 30 inches of mercury. Experiments made, by permission of Mr. Brunel, with the South Devon Railway atmospheric apparatus, confirmed the theory. The line traced by an indicator apparatus was shown to accord very closely with one traced by this theory, whilst it was widely at variance with the result of the ordinary theory.

[We must caution our readers against placing any confidence in the new law of the motion of elastic fluids, enunciated by Mr. Froude, which seems to us to be directly opposed to the fundamental laws of dynamics. If we suppose any number of particles acted on by external impressed moving forces, all in the same direction, the motion of the centre of gravity of the particles in that direction will be the same as the motion of the centre of gravity of a solid body of which the mass is equal to the sum of the masses of all the particles, and the moving force the sum of the moving forces acting on all the particles; and this law is true whatever be the nature of the connection between the particles or the mutual internal forces which they exert on each other. In the case of the motion of particles of fluid from an orifice—if the pressure at the orifice is constant, we confess we can see no reason why the quantity discharged in a given time should not be the same, whether the fluid be elastic or not—the question of elasticity or non-elasticity involving merely the internal or molecular connection of the discharged particles. We wish, instead of the brief and not very intelligible abstract inserted above, we had been favoured with Mr. Froude's unabridged analysis. If his views be correctly reported, it seems to us that he has confounded mass with volume; at all events, his results lead to an evident absurdity—viz., that if air were perfectly elastic (as indeed it is very nearly), and the vacuum in an air-pump were perfect, on opening the cock of the receiver no air would flow in. We think that if Mr. Froude repeats his experiments with a well constructed air-pump, he will be convinced that he is mistaken. Let him take an exhausted receiver, with a mercurial gauge, and having opened the cock, note the times of the mercury rising from 0 to 5 inches, 5 to 10 inches, 10 to 15 inches, respectively;—why our ear at once detects the absurdity. Who has not noticed how the hissing of the air, as it rushes through a small orifice into a vacuum, changes from a shrill to a hoarse note? There is no doubt that the law of theory is not fulfilled in practice, but that is owing to the friction—or rather resistance—arising from the particles of air striking, with enormous velocity, against the inequalities of the small tube. Neither is it possible—at least in the present state of analysis—to estimate exactly the pressure at the orifice. But the same difficulty holds in the case of inelastic fluids,—for the motion of which, we refer the reader to a paper in the Journal for April; one or two errors which escaped us at the time, in the proof, will be found corrected in the Number for June. For the "back pressure," we recommend our readers to turn to the Count de Pambour's valuable work on the steam engine.—EDITOR.]

June 22.—"An Account of the Plans that have been Proposed for Connecting the Atlantic and Pacific Oceans by a Navigable Canal." By Mr. JOSEPH GLYNN, M. Inst. C. E.

The author took a review of these projects from the time of Cortez, who proposed to cross the Isthmus of Tehuantepec by joining the waters of the River Coatzacoalcas, which flows into the Gulf of Mexico, with those of the River Chicapa, flowing into the Pacific, by the Bay of Tehuantepec; a plan which has lately been revived by Don José de Garay, who, with the assistance of Signor Moro, surveyed the country from sea to sea, and showed that the chain of mountain is there broken for about 35 miles, giving place to an elevated plain or table land, called the Mesa de Tarifa, where both these rivers originate, and where their junction could be easily effected. The objections to this plan are, the length of the river navigation, about 200 miles, and the ascent of the stream to the Mesa de Tarifa, about 200 metres, or 656 feet above the ocean. The survey was made under the patronage of the Mexican President, General Santa Anna, who professed to grant many important privileges to the promoters. The Isthmus of Nicaragua was next examined, and after that the course of the River St. John to the lake, which is a little more than 15 miles distant from the Pacific Ocean, and about 130 feet above its level. The distances and the levels were accurately taken by Mr. Bailey, an officer in the Royal Marines, by desire of General Marazon, President of the Central American Republic. The ridge of hills intervening between the lake and the ocean, and the uncertainty of the waters in the River St. John, alternately swollen by the rains, or dried up by the heat of a tropical sun,

the volcanic character of the country, and the unhealthy nature of the climate on this river, from which Lord Nelson's expedition suffered so much, render the execution of such an undertaking at this place very improbable. The Isthmus of Panama presents fewer obstacles than any other point—the distance from sea to sea is only about 39 miles—and the country is traversed for nearly the whole width by the great river of Chagres and its tributaries, which are interlaced, as it were, with the streams flowing to the Pacific. The chain of mountains here sinks into extensive savannahs and forests, with a few detached and isolated hills, and small elevations, seldom exceeding 500 feet in height. The country was surveyed in 1828, at the instance of General Bolivar, by Mr. Lloyd, an English officer, who also took the levels, and determined the difference between the two oceans to be 3½ ft. (3·52), the waters of the Pacific being the highest. Mr. Lloyd's valuable papers, deposited with the Royal Society, and the Royal Geographical Society, were exhibited to illustrate the paper. A survey of the River Chagres was also made by order of the Admiralty, during which Captain Foster, of her Majesty's ship *Chanticleer*, lost his life. The maps, plans, sections, and other valuable information deposited with these societies, seem to have created but little interest in England; but they have been diligently examined, and extracts and copies taken by foreigners, who have had free access to them, especially by the French; and M. Guizot lately sent M. Napoleon Garelli, as engineer-in-chief, with a numerous staff of assistants, to make a further survey, and ascertain the practicability of making a canal. This survey has fully confirmed that of Mr. Lloyd, and proves that there are no obstacles which engineers and contractors of the present day could not encounter and overcome without much difficulty or expense; the difficulties being more of a political character, and to be dealt with by statesmen rather than by engineers.

The meeting was very fully attended, and an interesting discussion ensued, in which his Royal Highness Prince Louis Napoleon took an active part. He had evidently studied the subject carefully on the spot, and traced a line between the lakes Nicaragua and Leon, which he recommended as preferable on account of the local facilities, the salubrity of the climate, the already populated character of the country, and the advantages of the two lakes, which, at small expense, may be converted into harbours, accessible at all times for vessels of heavy tonnage. The plans proposed by his Royal Highness appeared to meet the views of the meeting, as far as a ship canal was concerned; but it was agreed that for quick transit by railway, the lines traced by Mr. Lloyd over the Isthmus of Panama were to be preferred.

CONVERSATION.—The President, Sir John Rennie, gave his two conversations on May 29th and June 5th. The latter of these was one of the best conversaziones of the season, forming a grand union of the men most eminent in science, literature, and art. Additional rooms were thrown open in Sir John Rennie's mansion, and the personal attention of himself and Mr. Charles Mauby, the Secretary to the Institution, to the hospitable entertainment of the guests, made the meetings particularly pleasing. The leading feature in the model-rooms was a grand collection, illustrative of the progress of ship-building, from the time of the Pett's to the last productions of the Surveyor-General of the Navy. Next to them came a series, showing what has been done in electric telegraphs and clocks. A mass of electric telegraph lines gave singular evidence of the extension of the system, which has now become a recognised branch of public service. It is a curious sign of the age, to notice the *Times*, in a late number, complain of the mismanagement of the Rugby telegraph, by which they were deprived of their accustomed racing news. The visitors were so numerous that we may readily be excused for missing many of the most prominent. The Grand Duke Constantine of Russia, being unable to attend in the evening, went with his suite to a private view of the models.

Count D'Orsay contributed some statuettes and busts of the Emperor of Russia, Daniel O'Connell, the Duke of Wellington, &c., which were deservedly much admired. Paintings and sketches by Landseer, Oliver, Buss, Wood, Scanlan, Digby, Wyatt, Boxall, and Ward; enamel paintings, by Bone; chalk drawings, from Mr. Fuller; and some beautiful sketches, from Messrs. Ackerman's collection, were profusely scattered throughout the rooms. Taylor, Williams, and Jordan, had some excellent specimens of machine carvings; and Mr. Rogers some delicate examples of hand carving.

A series of models from the Admiralty exhibited the construction of a 50-gun ship at various epochs. Other models illustrated the most approved forms of bows, sterns, and midship section; and the general lines of the vessels composing the experimental squadron were contrasted by a series of uniform models. The wave principle was illustrated by models from Mr. Scott Russell and Dr. Phipps; and the progress of the steam navy was exemplified by models of vessels and engines, constructed by Messrs. Rennie, Maudslay, and others; with screw propellers by G. Rennie, Woodcroft, Hays, and Maudslay. Models of Brunel's block machinery, and Hurwood's patent scuttle, were appropriately introduced.

All the various systems of electrical telegraphs were represented, and were at work in the apartments:—Bain's electric clock—Nott and Gamble's single-wire telegraph—the Electric Telegraph Company's system, as used at the Admiralty—Brett and Little's apparatus, and Brett's writing telegraph, in which, by depressing a series of keys, corresponding letters are brought into contact with a continuous strip of paper, and the communication is printed at any number of miles distant.

Mr. Cowper contributed a series of models of the old French and other telegraphs, in order to form a contrast with the present instantaneous methods of communication.

There was a series of models of bridges of all kinds, amongst which we remarked one of corrugated cast-iron, erected by Mr. Barlow on the Tunbridge Railway.

The wrought-iron tube bridge, by Mr. R. Stephenson, at Conway, beautifully shown, on various scales, by Salter's elegant card-board models.

A cast-iron girder bridge, by Mr. Borthwick, of the same construction as that over the Dee, at Chester.

The drops for loading coal vessels at the Bute Dock, Cardiff, by Mr. Highton, appeared to be an ingenious modification of the system used in the north.

Stephenson's long boiler locomotive, Bessemer's axles, Dunn's turntables, Stevens's railway signals, and Clarke and Varley's new atmospheric railway tube, formed an interesting series of railway models.

Cochrane's machine for sawing out carved timbers of all forms, without waste, was worked, and was universally admired. It was stated that these efficient machines were now being introduced into the royal dock-yards.

Little's new printing machine, by which the number of sheets now dispatched, great as the quantity seems, can be doubled, was also at work, and excited much attention.

A curious clock, made by Tompion, in 1670, and presented by Charles I. to the Duchess of Cleveland, was exhibited by Mr. Vulliamy.

M. Praget contributed some extraordinary specimens of gold electro-deposit for ornamental work for clock cases, &c. It appeared from the statements that this introduction would make a great diminution in the price of this kind of work.

A collection of fossils, from the Oxford clay, at Trowbridge, made by Dr. Mantell, during the excavations on the line of the Wilts, Somerset, and Weymouth Railway, appeared to excite attention among the geologists—as did two casts of impressions of the feet of some unknown species of animal, found in the new red sandstone in the United States, and recently transmitted to Dr. Mantell.

A revolving disc pendulum, by Mr. Fronde, for rendering uniform the circular revolution, under considerable variation of the maintaining power.

Otis' American Excavator, which was worked on the Eastern Counties Railway, by Mr. Hyde, and that of Messrs. Barber, Brothers, invented by Colonel Hamilton, and now in construction for dredging the port of Toulon, were placed with Prideaux's Excavator.

A model of the Somerset-bridge, of 110 feet span, by Mr. Brunel, on the line of the Bristol and Exeter Railway, an example of the strength and simplicity that may be attained by well-constructed trussed timber bridges.

Fuller and De Berque's application of thick rings of vulcanised India rubber, alternating with metal discs, to form buffer springs for railway carriages.

Davidson's system of cleansing casks, as used at Truman and Hanbury's, and other breweries.

SOCIETY OF ARTS, LONDON.

At the Annual Meeting, which took place on Thursday, June 10, in their Great Room in the Adelphi,—H.R.H. Prince Albert, as President of the Society, filling the chair. His Royal Highness congratulated the Society on its increasing prosperity and usefulness; and proceeded to confer the honours which had been awarded to authors of important works or inventions in arts, mechanics, and manufactures submitted to the Society during the past year—and many of them exhibited at their late Exposition. The list of medals, &c. awarded on the occasion is as follows:—

THE GOLD MEDAL to Messrs. Davidson and Symington, for their method of applying Currents of Heated Air to Seasoning Timber and to the various Manufactures—Messrs. H. Minton and Co., for the Models of a Jug and Loving Cup—Mr. Thomas Drayton, for his new process of Silvering Glass with pure Silver—and John Everett Millais, for his Original Composition in Oil.

THE GOLD ISIS MEDAL, to Messrs. Richardson and Co., for their specimen of Enamelled Colours on Glass—Thomas Brown Jordan, for his Machine for Carving Wood, Stone, &c. for ornamental and decorative purposes—Mr. Henry Grainger, for the best specimen of White Earthenware—Messrs. B. Minton and Co., for the best specimen of White China—The same, for the best specimen of Deep Blue Colour on China—and the same, for the best specimen of Green Colour on Porcelain.

THE LARGE SILVER MEDAL and 10l. 10s., to Messrs. D. Pearce and C. Worrall, for their design and model of a Lamp Pillar—Mr. Charles Meigh, for a model of a Mug ornamented in relief—and M. F. Abate, for a means of Preventing the Emission of Noxious Vapours from Sewers. The same Medal and 5l. 5s., to Mr. John Strudwick, for his design for a Roller Window Blind—Mr. Daniel Pearce, for his design for Printing on China—Mr. John Phillip, for his design for an Earthenware Mug ornamented in relief—Mr. Bedlake, for his design for a Geometrical Stamped Drugget—and Mr. J. Austin, for an Original Composition, and specimen of Stained Glass. The same Medal and 3l. to Mr. G. Inman, for his Compass Plan. The same Medal, to Mr. Horne, for his Block Printing in Distemper—Mr. Edward Keys, for his model of a Mug ornamented in relief—Captain Carter for his method of Suspending a Knapsack—Mr. Fuller, for the application of Vulcanized India Rubber to Railway Buffer Springs—Mr. M'Sweny, for his improved double cone barrel Steering Wheel—Mr. C. J. Varley, for an Apparatus for facilitating the use of large Gregorian Telescopes—Mr. R. Day, jun., for his Model in Plaster of the Martyrs' Cross, Oxford—Mr. W. Ford, for his Original Model of a Figure of Nebuchadnezzar—Mr. C. S. Kelsey, for his Original Figure of a Greek Youth—Mr. E. J. Physic, for his reduced Model of a Figure of Mercury—Mr. Westerburgh, for his Portable Level—Mr. J. Walker for his Model of a Sewer Trap—Mr. Chadley, for his plan for Preventing the Emission of Noxious Vapours from Sewers—Master H. Bursill, for a Cast from an Original Model of the Figure of Hercules—and Master Alexander Stanesby, for a Chalk Drawing of Apollo from the round.

The SILVER ISIS MEDAL and HONORARY TESTIMONIAL, to Mr. W. Wood, for his Taphograph for the use of the Blind. The same Medal and 11. 1s., to Mr. G. West, for his Microscopic Drawing of the Spine of the Echinus. The same Medal, to Mr. J. Bolton, for an Instrument for facilitating the Cutting of Screws—Miss Susan Durant, for an Original Bust in Plaster, being a Portrait—Mr. C. Worrall, for a Model in Plaster of a Candelabrum—Mr. C. Fox, for an Original Composition in Plaster—Mr. C. Hodgetts, for an Original Chalk Drawing of the Gladiator—Mr. J. G. George, for a Chalk Drawing of the Gladiator—Mr. Arthur O'Connor, for a Chalk Drawing of the Head of Jupiter—Miss Mary Elizabeth Dear, for a Portrait in Chalk and other Drawings—Mr. H. Sousa, for a Design executed in Metal of the Head of a Greek Warrior—Miss Jane Campbell Bell, for a Chalk Drawing of a Head—Mr. F. Sands, for an Oil Painting of Birds from Nature—Mr. E. Hughes, for a Chalk Drawing of the Statue of Mars—and Mr. F. Wright, for a Clock Case carved in wood. The Silver Palette, to Master James Webb, for a Sepia Drawing of a Tree from Nature. Honorary Testimonial and 31. to Mr. Willett, for an Apparatus for facilitating the Collection of Liquid Manure. Honorary Testimonial, to Mr. Thomas Lambert, for a Flexible Diaphragm Water Valve—Mr. G. F. Bayley, for his Brush for Tubular Boilers—Mr. W. Milton, for an improved Angular Drill Stock—and Mr. T. Restell, for his Compensation Pendulum.

In addition to the foregoing premiums, various sums of money, amounting together to 45 guineas, have been awarded to the authors of works of merit in Art as connected with manufactures.

THE DECORATIONS OF COVENT GARDEN THEATRE.

Mr. LAUGHER read a paper at the Decorative Art Society on the Decorations of Covent Garden Theatre, 1847, considered in their relation to art. Alluding to the practical difficulties to be overcome in so brief a period, he said, that he was disposed to attribute some of the defects in the design to the necessity of using such available embellishments as the experience of the architect enabled him to collect *instantly*; and while admitting that much energy and some discrimination might be detected in some of the operations, he contended that the selection of an ornamental material in which the architect is avowedly interested, and its unskilful application, were equally remarkable. The material thus alluded to is called *cannabic*; and was described as being composed of the refuse part of flax, held together by a bituminous matter, and pressed in thin sheets into intaglio moulds, producing thereby a *basso-relievo* surface at rather less expense, and of greater lightness, than papier mâché and similar substances. The author considered this material a useful auxiliary in decoration; but in the present case, the distance at which it is placed from the point of view, together with injudicious colouring and an excess of burnished gilding, cancel the interest which under favourable circumstances accompanies its adoption. Mr. Laugher complained of the gloomy and heavy tone of red and shadow pervading the boxes:—the divisions being covered with crimson and marone figured paper, with a crimson carpet on the floor, crimson curtains and valances; while the light impinging over a smoothly stuffed cushion in front covered with crimson silk, diffuses a red glare by no means favourable to the appreciation of colour elsewhere. The arrangement of the curtains and valances was said to be meagre; and it was assumed that the whole had been intended to offer a quiet effect, with a reliance on the value of the silk for imparting respectability. The grounds on which crimson had probably been selected for these purposes were discussed. If as a background to a picturesque development of the audience, it was said that it totally failed—and if with reference to the effect of the general interior, the result was to be condemned for the objectionable and inartistic effect of the horizontal strips in white and heavy-toned red in harsh and forcible contrast, placed moreover without apparent vertical support. The carved fronts to the boxes were not considered equal in respect of form to those at the St. James's Theatre; and the general effect of colour upon them was described as pallid and faint—which an excess of *burnished* gilding does nothing to relieve. It was argued that gilding ought to be burnished only in a very slight proportion when placed on a white or a light coloured ground; and that the burnishing had in this case completely confused the delicate *basso-relievo* forms of ornament. The ceiling, it was observed, offers an agreeable repose to the eye in the circular range of graduated green with the full-toned browns prevailing in the marginal decorations. The general effect of the colouring throughout the embellishments is influenced in a remarkable manner by the crimson boxes in which the spectator is placed; and this, it was argued, constitutes the key-note to which other parts offer but little accordance. It was suggested that a charming effect might be obtained by the application of different colours for the curtains of the respective tiers—also that the divisions in the boxes ought to be of a neutral colour. The character, treatment, and propriety of selection in various details of the embellishments upon the box fronts were described and commented upon. It was said that forms of ornament prevailing at almost every period had been applied:—ancient Greek, Roman, Renaissance, Louis XIV., Louis XVI., and modern French combination, had each assisted to confuse and debase, in the motley arrangement, the attributes whose aspects they wore; while the ceiling itself, which it was stated is almost the only portion partaking of artistic manipulations, owes its merits to examples of Le Brun. The introduction thereon of ropes and masks in *basso-relievo*, and meretricious glitter of gilding, whereby the allegoric subjects appear in abeyance, were considered to mark the loss of skill between the artists of that and those of the present period.

[We do not by any means concur with Mr. Laugher in his sweeping conclusions. We cannot see how the lining of the box can serve as the key-note to the other decorations, and it has never produced that effect on us. We likewise differ from him *in toto* as to the want of effect of the crimson as a background to the audience, for we agree with those who hold that it ad-

mirably sets off the dresses and appearance of the company, as indeed on theoretical grounds it might naturally be expected to do. We suspect Mr. Laugher has seen the house when there was no audience in it. We are glad, however, to acknowledge in Mr. Laugher's essay a praiseworthy endeavour to raise a higher standard of criticism.—EDITOR.]

THE STEAM JET FOR VENTILATING.

Professor FARADAY, in a former lecture delivered at the Royal Institution "On Mr. Barry's method of warming and ventilating the new House of Lords", mentioned that a part of the means employed for securing a current of air sufficiently abundant to insure the required object was the use of a jet of high-pressure steam in the ventilating shaft of that building. At a recent meeting Mr. Faraday explained the physical conditions of such a steam-jet, and the relations of the vapour discharged from it to the surrounding air.

More than forty years ago, Dr. Young (Nat. Phil., vol. ii., p. 534) had shown that wherever any elastic fluid was forced from a jet with but small velocity, the steam proceeded for some inches without observable dilatation, and then diverged into a cone; but that when the pressure on this vapour was increased, the apex of the cone approached the orifice of the jet; but whatever might be the amount of this pressure, the form of the cone continued the same. Mr. Faraday proceeded to notice the lines of motion of the particles constituting this cone of vapour. The rings of smoke produced by the combustion of bubbles of phosphuretted hydrogen on the surface of water were exhibited. The revolution of each of these hollow rings on the axis of the cylinder which forms it was pointed out, as was their gradual expansion when rising into the air: and it was shown that each of these enlarging rings might be viewed as a magnified element of the cone of steam issuing from the jet. In the same class of effects Mr. Faraday placed the rotating clouds of smoke which are seen issuing from the chimneys of steam-boats, &c. The force with which the particles of the air surrounding the cone of steam produced by a powerful jet were drawn towards it, were shown by various striking experiments. Hollow balls of 1 and 2 inches diameter were seen drawn into the cone, and sustained floating in the line of its axis, even when, by an arrangement of the apparatus, this axis was brought 35° out of the perpendicular. An upright glass tube, 18 inches long and 1 inch diameter, having one extremity plunged into water and the other end drawn into a capillary jet was visibly exhausted of its contained air (the water being drawn up from the lower end of the tube) when the capillary jet was placed within the in-draught of air occasioned by the cone of steam. In closing this part of his subject, Mr. Faraday explained the use which has been made of a cylindrical or conical jacket to include this steam-cone, and thus to increase the draught-power of the jet. In the arrangement adopted by Mr. Barry for ventilating the House of Lords, this jacket is the ventilating-shaft itself; so that there can be no room for the entrance of air to form a downward current in the shaft. This mode of moving air has been adopted in lead-works and other manufactories, for the purpose of washing and condensing the smoke where noxious fumes are generated in the processes. Noticing the coolness of the high-pressure steam, even near the orifice of the jet, as being due to the quantity of cold air rushing towards it and diminishing its temperature, Mr. Faraday connected with this and the other phenomena the experiment of M. Clement Désormes—who showed that when steam, under high pressure, is allowed to escape from an orifice pierced in a plate, and a flat disc is brought close to this plate, the plate and disc are made to adhere together. In this case, the elastic force of the steam issuing from the jet, and which tends to separate the plate and disc, diminishes rapidly in its course from the centre to the edges of the disc; at the same time, the radial currents by their in-draught, as before illustrated, bring the two plates together with a power which is so much greater than the former that the surfaces adhere. Mr. Faraday finished by noticing the danger of conical safety-valves in high-pressure boilers, when the lateral expansion of the conical surface is large in proportion to the sectional area of the steam passage.

TIRES OF RAILWAY WHEELS.

The following remarks have been communicated by a correspondent ("X. Y. Z."), to the *Railway Record*:—"It was given in evidence, at an inquest recently held to decide upon the fatal results of an accident which occurred on the Great Western Railway, that the fracture of the steel tire of the driving-wheels of some of their locomotives was by no means an unusual occurrence, and that even those tires sometimes snapped when the engines were not running. The dreadful effects of the accident in question make it evident that nothing should be omitted by which risk may possibly be mitigated; and to this end, among, probably, many better suggestions, I beg to offer the following, both as respects the cause and its removal.

"These steel tires are dovetailed into the iron wheel; and being let in hot, it appears to be assumed that the sledge hammers of the forgers will cause the two metals—steel and iron—to become properly welded together. Now this I venture to dispute; on the contrary, I am convinced nothing like a real cementation of the two metals will be effected. If this assumption

be correct, it necessarily follows that the iron felloes of the wheel will be surrounded by a distinct steel hoop. Now, the transverse section and body of hoop is very small, compared with that of the felloes, or iron rim, of the wheel—consequently, under the enormous pressure of a Great Western locomotive, the steel hoop will have a tendency to *roll out* longitudinally more than the iron rim of the wheel; and, so rolling out or stretching, it must either fracture the felloes, or the iron rim itself, if it is let into its dovetailed bed very tight; or it must become somewhat larger in diameter than the felloes of the wheels. If this latter be the result, we know that the wheel and the steel tire cannot, without a jerking back of the tire, make the same number of revolutions in any given distance. A tire so enlarged, on an iron wheel, will, when the wheel is in revolution with a heavy load upon it, be rolled down tight into its bed at all points behind that of its contact with the rail; and, at all points before that, it will be thrown partly up and forward out of its bed, by so much as it is larger in diameter than the felloes of the wheel. But when, from any cause—such as an increase of speed, or at some portion of its bed where the steel rim fits tighter—this kind of slipping of the larger outer rim on the smaller inner one, can no longer be maintained, the outer, that is the steel rim, must snap, and its fractured pieces frequently fly off with great force. But it is stated that these tires sometimes snap when the engine is not in motion. Here the laws of expansion and contraction, probably, come into action. Supposing a steel tire not to have been rolled out, as previously assumed, in running; then, when the engine comes to a state of rest, the wheel will begin to discharge into the atmosphere the extra amount of heat it has acquired during its rapid journey; and, though the contractive forces of iron and steel are, in like conditions, nearly the same, yet, the tire being the outside, will cool faster, and contract at first more than the body of the wheel; and hence it will be likely enough to snap, particularly when the hardness of the steel is considered. The converse of all this even might account for the flying off of those tires when running, without supposing there were any rolling out of the metal under the enormous load of the engine, with all its *hammering* on the rails. Now, if the cementation of the steel tire and the iron felloes of the wheel were perfect, the risk of all such accidents would seem to be obviated; and this occasions me to mention, that I some time back observed that a patent had been taken out by a Sheffield gentleman—I think of the name of Sanderson—for welding a steel plate, of sufficient thickness, on an iron bloom, and then rolling out into bars. In fact, it seemed to me that this was a plan for plating iron with steel, precisely on a similar method with that of plating copper with silver, as long practised in the well-known Sheffield plated ware. I have not been in the way of learning whether this patent has been successfully worked out; but it appears to me it might be well worth the while of any railway company using steel tires to inquire.”

ARMY AND NAVY CLUB-HOUSE.

Table of Dimensions of Coffee-Room, &c., in some of the Designs.

No.	Architect.	Coffee-Room.		Morning-Room.		Drawing-Room.	
		ft.	ft.	ft.	ft.	ft.	ft.
28 ¹	Tattersall	68 by 21	1428	55 by 24	1320	55 by 21	1155
55 ²	Fowler and Fisk	100—32	3200	56—33	1848	101—29*	2953
1		56—25	1428	46—22	1012	—	—
3		54—29	1543	42—29	1218	54—29	1593
12		80—27	2160	56—28	1568	56—25	1400
13		97—23	2231	56—28	1568	47—23	1081
14		64—30	1952	30 6—30 6	930	—	—
15	Fiddian	98—30	2940	44—25	1100	98—30	2940
18		42—32	1344	53—32	1196	53—32	1696
20		75—29	2175	58—29	1682	—	—
23	Salvin	85—30	2550	58—30	1740	58—30	1740
33		85—27	1685	58—21	1218	58—21	1218
38	Lamb	90—23	2070	98—21	2058	98—21	2058
39		80—31	2480	88—26	2332	66—26	1716
40	Johnson	70—30	2100	57—27	1539	57—26	1482
44	Owen Jones	65—39	2535	39—30	1080	65—39	2555
46	Parnell & Smith	70—34	2580	52—24	1248	55—30	1650
49	Granville	85—28	2462	58—28	1653	58—28	1653
50	Fripp	80—31	2480	48—24	1176	80—31	2480
53		62—29	1829	55—29	1620	—	—
57	Alexander	81—32	2592	42—31	1302	—	—
58		84—30	2520	56—26	1484	68—30	2040
67		93—27	2511	55—27	1499	55—27	1499
69	Papworth	80—40	3200	56—28	1568	56—28	1568
	Travellers' ..	68—24	1066	43 6—24	1065	39—23	900
	Reform ..	105—27	3105	58—28	1624	115—27	3105
	Conservative ..	80—28	2280	92—26	2438	92—26	2438

* Including Library.

ARMY AND NAVY CLUB DESIGNS.

DEAR SIR,—On the part of my brother and myself, I beg to say that we observe in your valuable periodical, at page 174 of the last number, that we are held up, *ex cathedra*, as being guilty of perpetrating an untruth in the design for the Army and Navy Club house, exhibiting by us in the gallery of the Royal Academy. As we took the trouble of making a drawing of Winchester House, for the purpose of regulating our own design, and also the liberty of sending to the secretary and committee that drawing, for the purpose of affording a test of the correctness of the designs submitted; and knowing, as we do, that the perspective of our drawing is correct, for it is our own handiwork, I beg of your justice to make this exculpation as public as the odium cast by your reviewer upon, dear Sir, Your obedient servant,

JOHN W. PAPWORTH.

10, Caroline-street, Bedford-square, 18th June, 1847.

* * I write this because, in a perspective view, such an error or liberty, as the case may be, is hardly, if at all, justifiable.

NOTES OF THE MONTH.

Avignon and Marseilles Railway.—A serious disaster has occurred on the new line of railway between Avignon and Marseilles, which was just ready to be opened. The viaduct which carried the railway over the river Neurthe, one of the principal works of art upon the line, has fallen. The particulars of this event had not reached Paris, but it appears that no lives have been lost. The damage to the company will amount to from two to three millions of francs.

Crimple Viaduct.—This magnificent viaduct will, when completed, form one of the most wonderful of the achievements of science in railway construction in the kingdom. Its massy towering piers are now all reared, and its lofty expansive arches, stretching their wide concavities across the deep glen, will shortly be brought to a close. Those of our readers who may be unacquainted with this structure, may feel somewhat interested by a brief description of its situation, and an accurate admeasurement of its gigantic form. Its situation is about a mile to the south-east of Harrogate; it is intended to convey the Harrogate and Church Fenton line of railway across the Crimble Valley. The viaduct consists of 31 arches, each of 52 ft. span, and the loftiest are 130 ft. in height. The piers on which they rest, 32 in number, are about 20 ft. each in thickness at the base, and are composed of immense blocks of hard granite. The top of each pier, immediately beneath the springer, is 8 ft., and the quoins 4 ft. in thickness. The abutments are thickly flanked, and joined by lofty embankments. The line at the south end is carried through a long deep tunnel; while at the opposite extremity it proceeds along a deep rocky cutting. The whole length of the masonry is about 1856 ft. Between the first and second buttresses at the south end runs the line of the Leeds and Thirsk Railway, which is carried along the mountain side a considerable distance, and afterwards thrown across the vale by another viaduct, which, however, appears very diminutive compared with the one described above. The part of the valley over which the monster viaduct is thrown, is a beautiful and romantic little defile between two high rocky mountains, whose steep and rugged sides are covered with a profusion of heath, brushwood, and other kinds of vegetable life, indigenous to the mountain soil.—*Harrogate Herald*.

The Exhibition of Oil Paintings at Westminster Hall, must be looked upon as satisfactory on the whole, while the awards of the Commissioners can scarcely be impugned. The works are 120 in number. The 500l. prizes are given to Mr. Armitage, for his *Battle of Meanece*, a most spirited work; to Mr. F. R. Pickersgill, for the *Burial of Harold*; and to Mr. G. F. Watts, for his *Sketch of Alfred inciting the English to meet the Danes at Sea*. The 300l. prizes are given to Messrs. John Cross, P. F. Poole, and J. Noel Paten. The 200l. prizes to Messrs. J. E. Lauder, Charles Lucy, and J. C. Horsley. Among the remaining meritorious works are those of Mr. S. Gambardella, Mr. Wm. Cave Thomas, Mr. Salter, Mr. Crowley, and Mr. Brunning. The great defect is in the choice of subjects, showing the want of liberal education on the part of the artists. It was not so in the middle ages; but now the artist thinks he need only study with his pencil, that he can learn enough by his own observations, without having recourse to the observations of others. The partisans of "art-cultus" and artistic neology had better look to this.

The Opening of Hartlepool West Harbour and Docks, situate near the village of Strauton, about a mile and a half to the south of Hartlepool, close upon the sea-shore, has taken place. The dock comprises an area of about eight acres of water, and has substantially-built quay walls on every side, and in cases of danger is calculated to afford a convenient place of shelter and security for a large number of vessels. The harbour comprises about fourteen acres of water, and is enclosed by two bold piers jutting into the sea, the whole built in the most solid and substantial manner. Vessels can always be afloat in the dock with twenty-three feet of water, if required. A graving dock has also been commenced.

OBITUARY—We have to record the death of Mr. John Buonarotti Papworth, late Vice-President of the Royal Institute of British Architects, which occurred on Wednesday, the 16th ult., at his residence, Park End, St. Neot's, whither he had retired from London, after more than fifty years of professional practice. Early in life, his excellent judgment and a kind heart acquired for him the intimacy of the leading artists, and also the confidence of many wealthy amateurs as to the direction of their patronage, and as to the decoration of their mansions; in this course he originated and accomplished the adoption of the tasteful style of modern furniture, from which cause he was selected by government to carry out the foundation of the School of Design at Somerset House. His works on garden and rural architecture, very favourably received by the public, were the results of his experience in landscape gardening, which he joined as a profession with his other art. Amongst the clients to whom he owed an extremely varied practice, he numbered several of the late branches of the royal family, especially the Princess Charlotte, and also the present King of Wurtemberg, from whom he, having designed the Palace and English Park at Kunnstadt, received the appointment of architect to his Majesty. His son will have the satisfaction of remembering how highly Mr. Papworth was respected, not only by his private friends and by his clients, but by those severer judges, the members of his own profession, to whose splendid token of their esteem we gave publicity at the beginning of the year.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM MAY 22, TO JUNE 24, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

Henry John Nicoll, of 114, Regent-street, Middlesex, tailor, for "Improvements in garments, and in pockets, bags, and other receptacles."—Sealed May 22.

Sydney Smith, of the county of the town of Nottingham, engineer, for "a certain improved apparatus for determining the pressure of steam in boilers, and regulating the dampers of a furnace."—May 22.

William Bridges Adams, of Old Ford, in the county of Middlesex, engineer, and Robert Richardson, late of Manningtree, in the county of Essex, but now of Hadleigh, in the county of Suffolk, for "certain improvements in the construction of railways, and of engines and carriages used thereon, and also in transport and storage arrangements for the conveyance, management, and preservation of perishable articles."—May 22.

Moses Poole, of London, gentleman, for "Improvements in the construction of pneumatic springs and presses." (A communication.)—May 22.

Jean Marie Fourmentin, of New Bridge-street, Blackfriars, gentleman, for "Improvements in the manufacture of carbonate of lead."—May 22.

William Edward Newton, of Chancery-lane, Middlesex, civil engineer, for "a new improved instrument or apparatus for making or manufacturing capsules for enclosing medicines, preparations, or other liquid or solid preparations." (A communication.)—May 22.

John Aitken, of Russell-street, Bermondsey, leather dresser, for "Improvements in steam-engines or atmospheric engines, in distilling and pumping water."—May 22.

William Dyne, of Rochester-terrace, Stoke Newington, Middlesex, corn merchant, and Morry Hagar, of Church-street, Stoke Newington, for "certain improved apparatus for protecting life and property in cases of shipwreck."—May 22.

Charles Chinnock, of 52, Regent's Quadrant, Middlesex, for "Improvements in regulating motion, and controlling friction in the joints and other parts of furniture, machinery, and carriages."—May 22.

Henry Le Lievre, of Cleveland-street, Mile-end, Middlesex, for "Improvements in dyeing and stretching silk, and in finishing plush."—May 24.

Pierre Armand Le Comte de Fontainebleau, of 4, South-street, Finsbury, London, for "certain improvements in the machinery for cutting wood, and in laying and uniting veneers." (A communication.)—May 25.

Christian Schiele, late of Frankfurt on the Maine, but now of Manchester, for "certain improvements in machinery or apparatus for condensing steam, which said improvements are also applicable to other similar purposes."—May 27.

Alexander Allan, of Crewe, in the county of Chester, engineer, for "certain improvements in turn tables, to be employed on, or in connection with railways, part or parts of which said improvements are also applicable to the construction of tubular boilers."—May 27.

Henry Gilbert, of Marina, St. Leonards, surgeon, for "Improvements in apparatus for holding sacks to facilitate the filling them with corn or other material."—May 27.

Henry McEvoy, of Hall-street Works, Birmingham, machinist, for "Improvements in the manufacture of, and in the packing hooks and eyes."—May 27.

Benjamin Thornycroft, of Wolverhampton, iron master, for "Improvements in the manufacture of rails for railroads."—May 27.

James Johnstone, of Willow Park, Greenock, Esq., for "certain improvements in the manufacture of sugar."—May 27.

James Biewitt, of Llantarnam Abbey, Newport, in the county of Monmouth, Esq., for "Improvements in the manufacture of malleable iron."—May 27.

Archibald Blooman, of Fleet-street, for "certain improvements in the processes and machinery employed in scouring and bleaching." (A communication.)—May 27.

Alfred Stevens, of 2, Queen's Terrace, Saint John's Wood, Middlesex, chemist, for "a new or improved preparation or preparations of certain substances for making various glutinous compounds."—May 29.

Francis Bernard Bekuert, of Rue Royale, Exterieur, Brussels, in the kingdom of Belgium, for "a method of increasing the quantity of cream procured from milk, and preserving milk."—May 29.

William Horne, of Long-acre, Middlesex, coach-maker, George Beadon, of Battersea Fields, Surrey, and Andrew Smith, of Millwall, Middlesex, engineer, for "Improvements in wheel carriages."—June 3.

Josiah George Jennings, of Great Charlotte-street, Blackfriars, for "Improvements in water-closets, and in making joints and connections of pipes."—June 3.

Christopher Nickels, of York-road, Surrey, gentleman, for "Improvement in the manufacture of woven fabrics, and in giving elasticity to certain articles of fabrics."—June 3.

John Hill, of Hulme, near Manchester, machine maker, for "Improvements in looms for weaving certain kinds of cloth."—June 3.

Thomas Woodbridge, of No. 10, Osborne-street, Whitechapel, Middlesex, corn-dealer, for "a certain improvement or certain improvements in steam engines."—June 3.

Samuel Benjamin Edward Berger, of Abchurch-lane, in the city of London, merchant, for "certain improvements in the construction of railway carriages."—June 3.

George Taylor, of Holbeck, near Leeds, mechanic, for "Improvements in the construction of engines and carriages to be used on railways."—June 3.

Richard Clark, of 447, West Strand, lamp manufacturer, for "certain improvements in the production of artificial light, and in burners, lamps, and candlesticks."—June 3.

Samuel Ellen, of Grange-road, Bermondsey, gentleman, for "Improvements in the manufacture of lish hide leather and other oiled leathers."—June 8.

Charles Larrard, of Leicester, machinist, for "Improvements in machinery for cutting wood for the manufacture of bobbins and other articles."—June 8.

Henry Cox, of No. 3, Chappel-place, Battersea Fields, Surrey, for "Improvements in the preserving and preparing of wood, bricks, tiles, and other substances."—June 10.

Bondy Asalay, of Rotherhithe, in the county of Surrey, printer, and Abraham Solomons, of the city of London, merchant, for "certain improvements in the manufacture of charcoal and other fuel."—June 10.

William Darling, of Glasgow, Scotland, iron-founder, for "Improvements in moulding, and in the manufacture of certain articles of cast iron."—June 10.

William Beckett Johnson, of Manchester, engineer, for "certain improvements in the construction of locomotive engines, to be used upon rail or other ways, which improvements are also applicable to carriages used upon railways."—June 12.

James Johnson, of Bradley, in the county of Stafford, iron founder and boiler maker, for "Improvements in the manufacture of rivets, railway, or other pins, bolts, nuts, and spikes."—June 12.

John Mercer, of Oakenshaw, and John Greenwood, of Church, both in the county of Lancaster, chemists, for "Improvements in certain substances applicable to the manufacture, scouring, and washing wool and woollen fabrics and other substances."—June 12.

George Edmund Donisthorpe, of Leeds, in the county of York, manufacturer, for "Improvements in weaving and spinning wool and flax, and in treating wool previous to spinning, and heckling flax."—June 12.

Joseph Wilcock, of Barnsby, in the county of York, gentleman, for "certain improvements in the ventilation of mines."—June 12.

James Richards, of New York, engineer, for "Improvements in constructing pistons."—June 12.

Francis Bowers Stevens, of Hoboken, in the county of Hudson, in the State of New Jersey, in the United States of America, engineer, for "Improvements in applying means and apparatus to ships and vessels, to improve their speed."—June 12.

John Lane, of Oriel-street, Liverpool, brewer, for "Improvements in railway carriages and engines."—June 15.

Richard Roberts, of Manchester, engineer, for "Improvements in machinery for preparing and spinning cotton, and other fibrous substances."—June 15.

James Timmins Chance, of Handsworth, in the county of Stafford, glass manufacturer, for "Improvements in the manufacture of glass." (A communication.)—June 15.

John Lane Higgins, of Oxford-street, Middlesex, Esq., for "Improvements in the construction of winches and windlasses."—June 15.

Frederick Theodore Philippe, of Beilfield Hall, in the county of Lancaster, calico printer, for "certain improvements in machinery or apparatus for stretching, drying, and finishing woven fabrics."—June 15.

Alexander Symons, of London-street, Fenchurch-street, merchant, for "Improvements in railway carriages in preventing accidents on railways, and ascertaining the speed of carriages."—June 15.

James Houghton, of Oldham, in the county of Lancaster, for "certain improvements in machinery or apparatus, to be used in the preparation and spinning of cotton, wool, and other fibrous substances."—June 15.

Henry Pooley, of Liverpool, iron founder, for "certain improvements in weighing machines."—June 15.

James Hill, of Staley Bridge, in the county of Chester, cotton spinner, for "Improvements in or applicable to certain machines for preparing, spinning, and doubling cotton, wool, and other fibrous substances."—June 19.

Samuel Keeling, of Hanley, in the county of Stafford, for "an improved method of making candlesticks."—June 19.

James Murdoch, of 7, Staple Inn, Middlesex, patent agent, for "an improved mode of manufacturing woven goods figured on both sides."—June 19.

Francois Henri Bieles, of Mayence, on the Rhine, gentleman, and Meyer Henry, of Colonial Chambers, Crutched Friars, merchant, for "certain improvements in rearing, manuring, or preparing corn, seeds, plants, and trees, and in fertilizing land."—June 19.

William Vickers, of Sheffield, steel manufacturer, for "Improvements in the manufacture of iron."—June 19.

Thomas Russell Crampton, of Adam-street, Adelphi, engineer, for "Improvements in locomotive engines."—June 19.

James Robertson, of Great Howard street, Liverpool, for "Improvements in the manufacture of casks and other wooden vessels, and in machinery for cutting wood for that and other purposes."—June 19.

John Macintosh, of Bedford-square, Middlesex, for "Improvements in engines to be worked by steam or other suitable fluid, and improvements in propelling carriages and vessels."—June 22.

James Soutter and William Frederick Hammond, of the Spread Eagle Works, Limehouse, engineers, for "certain improvements in the steam engine, and in machinery for propelling."—June 22.

John Obadiah Newell Rutter, of Brighton, gas engineer, for "certain improved methods of, or apparatus for conveying intelligence."—June 22.

Henry Mapple, William Brown, and James Lodge Mapple, of Childs Hill, Hendon, for "Improvements in communicating intelligence by means of electricity, and in apparatus relating thereto, part of which improvements are also applicable to other like purposes."—June 23.

John Richard Watson, of Pentonville, Middlesex, gentleman, for "an improved instrument for registering angles at sea."—June 24.

ERRATA.—In the last number of the Journal, in our review of Mr. Haun's "Treatise on the Steam Engine," page 195, for

$$x = p(1 - \cos \phi) + \frac{r}{2} \cos \theta, \quad \text{read}$$

$$x = p(1 - \cos \phi) + r(1 - \frac{1}{2} \cos \theta).$$

THE NEW PALACE AT WESTMINSTER.

(With an Engraving of the House of Lords, Plate XII.)

CHARLES BARRY, ESQ., ARCHITECT.

We this month, agreeably to our promise, give a second view of the interior of the House of Lords; it is a transverse section, or view of the north end, showing the Reporters and Strangers' Gallery. The archway under the centre of the gallery is the principal entrance to the House, and the side arches enclose two small waiting rooms or lobbies. The arches above the Gallery, and the centre one below, are filled in with cloth curtains. The front of the Galleries and the enclosure to the Lobbies below are of wainscot, and the arches above of stone. The faces of the spandrels and ribs are elaborately gilt, similar to the side elevation. The Plate is drawn to the same scale as the one in last month's Journal.

The following is Mr. Barry's report of the state of the works on June 30, 1847:—

The carcase works of the portion of the building towards New Palace Yard are entirely completed.

The Victoria Tower is about 90 feet high; the carving of the stone groin within it is completed, and the scaffolding is removed.

The Clock Tower is also about 90 feet high. Framed scaffolding and hoisting apparatus have been prepared, and are now being fixed for the upper portions of those towers, which are not yet contracted for.

The stone groin over the Central Hall is now being turned, and is far advanced to completion.

St. Stephen's Hall is in part carried up to its full height for the roof, and the remainder is, upon an average, within about 10 feet of the same level. St. Stephen's Porch and the western entrance of the building is carried up to the height of about 30 feet above the ground.

The Commons' public lobby, and the central masses of the building above the corridors and public staircase, are, upon an average, within about 10 feet of their full height.

The House of Commons' ceiling, beams, and bracketting, and the stone screens at the north and south ends of the house, are completed. The fittings and finishings of the house are not yet ordered, as no decision is yet come to respecting Dr. Reid's plans for warming and ventilating this portion of the building.

The House of Lords, the royal ante-chamber, and the house or public lobby, with all their warming and ventilating arrangements and apparatus, are (with the exception of a portion of the stained glass, the fresco paintings, statues, and other works of art) completed; and those portions of the building were occupied for the first time immediately after the Easter recess of the present year.

The fittings of the old House of Lords were removed during the Easter recess, the house converted into a gallery of approach from the House of Commons, and other communications made between the temporary and the new buildings.

The fittings and finishings of the libraries and refreshment rooms are near completion. A considerable extent of joiners' work in ceilings is prepared: much of it is fixed, and other finishings are executed in other portions of the building.

Ten new committee rooms in the river front have been temporarily fitted up for use since Easter.

There are at present 1,276 men engaged upon the works of the New Palace, of whom 708 are employed at the building, 147 at the quarries, 228 at the government works at Thames-bank upon the joiners' fittings and wood carvings, and 193 upon miscellaneous works both at the building and elsewhere.

A *Builders' Benevolent Institution* is about being established for the relief of decayed masters in the building business, and also for the relief of workmen in the employ of a subscriber, who may meet with an accident; it is also proposed to establish Alms-houses when an adequate sum can be raised.

CANDIDUS'S NOTE-BOOK.

FASCICULUS LXII.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. "Why work we not as our forefathers wrought," is a question that was put by Mr. Scott as the motto to his design for the Army and Navy Club-house. No doubt it is one which he considers unanswerable; yet the design itself furnished a tolerably conclusive reply, as did likewise one or two others which appeared in similar architectural masquerade, having assumed the costume of mediævalism. Clubs and Club-houses, however, are institutions belonging exclusively to modern civilisation and refinement. In former times, there was nothing whatever analogous to them, unless it were convents,—cenobitism, or living in common, and the exclusion of the society of the other sex, being one great characteristic of both. Yet there all resemblance ends; modern cenobitism being of quite a different stamp from that which was in vogue among our "forefathers." Everything has been metamorphosed—either greatly reformed or else grossly perverted. The Coffee-room has taken place of the Refectory, and the epicurean *carte* has put the meagre days of the "good olden times" to flight. Are the latter, then, to be now restored?—or are we to return to mediævalism only by halves? If we are to be archaic in our buildings, why not also in our dress, in our speech, in our amusements? Why do we not dine as our forefathers dined? And we might go on adding question of the kind to question, till we asked: why are we not our veritable forefathers themselves?—Sentimental *archæomania* is one of the fashions of the day, and one whose very extravagance will sooner or later bring it into contempt, when it will be put on the same shelf with bibliomania and other exploded follies. Like bibliomania itself, *archæomania* is—although it does not absolutely exclude them—quite independent of any knowledge of, or taste for, the intrinsic æsthetic value of the class of productions it concerns itself with. The one prides itself upon estimating buildings as the other does books—by merely extrinsic circumstances, instead of judging of them by their architectural or literary worth. The building may be rubbish, the book may be—rubbish also; but if the one can be proved to be of the date of the Conquest, the other be a black-letter edition—perhaps an unique copy in the original binding—your *archæomaniac* and your *bibliomaniac* fall into ecstasies,—that is, provided there be anybody present to witness them, such raptures being themselves far too valuable to be acted in private. Your *archæomaniac* will, perhaps, be able to tell you the date of every part of a cathedral, and the names of all the respective bishops or other founders, together with many other, no doubt, highly *curious*, yet altogether extrinsic, matters; but ask him for a critical elucidation of individual and aggregate beauties, and he stares at you with contempt, if not with horror—probably the latter, for he feels very uncomfortable in your company. You seem to expect something like reasoning *nous* from him; while he demands the unquestioning admiration of implicit faith from you.—Go to! you are a heretic!

II. Among the designs for the same building, namely, the Army and Navy Club-house, was another Gothic one that was an absolute bargain; for, although it showed a lofty structure, bristling with pinnacles, and crowded with canopied niches and their statues, and the whole was to be executed in real stone, the estimate was neither more nor less than the exact £30,000; which rigorously prescribed sum was *conscientiously* adhered to by nearly every one of the competitors, notwithstanding the prodigious difference of the designs themselves, in regard to a great variety of circumstances affecting cost. But, alas! even such tempting bargain as the design alluded to, did not tempt the gentlemen of the Army and Navy Club. Perhaps they rather looked at that and the other Gothic designs with *con-tempt*, as silly *at-tempts* to make them make monkeys of themselves, by aping the architecture of monkery and monkish times. Let us not mock "our forefathers," by substituting mere mummery for art.

III. We have outgrown mediæval architecture. It is a garb which, besides that it ill accords with the rest of our social costume, would require to be enlarged—to be both greatly lengthened and widened, in order to fit it to the present stature of civilization. It may become the church well enough, as being of the true clerical cut and "cloth." But for ordinary purposes, and all sorts of purposes,—that is not to be thought of seriously. Nevertheless, it is stated that the Carlsruhe Theatre, which was lately burnt down, is to be rebuilt in the Gothic style—at least, some such idea is enter-

tained, and Heideloff has been specially invited to furnish designs in that style. Still, complimentary as this looks to Gothic architecture, it may fairly be questioned whether the compliment will not be resented rather as an insult, by the staunch advocates for mediævalism. To apply such a style to a theatre will be deemed by them little less than a downright profanation of it. One inevitable scandal will be, that Precedent must be rudely shoved aside, there being no precedent whatever for any *profane* structure of the kind in all the remains of the middle ages. Innovations, and very extensive ones, there must be, in order to accommodate the building to its express purpose. The idea is not, indeed, quite new to the Germans, a private court theatre having been built some few years ago, by Ottmer, in a sort of Gothic—but of such sort, as would certainly scandalise our Pugins and our Willis. Whether Heideloff will acquit himself of the difficult task imposed upon him, much more satisfactorily, may be doubted, since the very fact which is alleged as peculiarly qualifying him for it, must in a great measure disqualify him also; because if he has all along devoted himself exclusively to the study of Gothic architecture and art, he must come quite unprepared to such a very special subject as a theatre, which is, moreover, one that demands ability of a particular kind. His designs for Gothic furniture do not promise much for his power of invention—that species of invention which consists in re-combining forms and details into novel applications of them, and adding others to them where necessary, conceived in the same spirit and treated with the same gusto.

IV. Although in his lately published lecture on the "Education and Character of the Architect," Professor Donaldson earnestly recommends the study of biography, and especially commends Milizia's "Lives," he seems to think that no farther dose of biography is now wanted. At least, he has expressed no desire to see some one undertake a continuation of that work, bringing it down to the present time. Such a continuation of it ought to be fully as interesting as Milizia's work, which, to say the truth, hardly pretends to be a readable book, though useful enough as one of mere reference. To say the truth again, there is very little that answers to the idea of biography in it, most of the lives being very jejune notices of the individuals themselves, with a dry enumeration of their principal buildings. The subjects of such biography have since then greatly accumulated, although it must be confessed that materials for them are in many instances very scanty, owing to their not having been collected while they were within reach. Still there is very much lying scattered about, which requires only to be searched out and put together. It will, perhaps, be said that in the two last generations of architects who have gone off the stage, there were few who distinguished themselves either by great works or great talent. Still, there were many of celebrity, whether that celebrity was merited or not, and several of great ability also,—persons quite as worthy of a niche in biography, as are a very great many of those recorded, and merely recorded, by Milizia. It is in one respect all the better if there are comparatively few to be spoken of, because in that case there is room for biographical narrative and critical remark. Something more attractive and instructive also than such mere *skeletons*, as many of the notices in Milizia are, is highly desirable;—something sufficiently readable to impress itself on the memory;—something analogous in plan to "Johnson's Lives of the Poets." Properly written, the biographies of architects, or indeed any artists, might be made to comprise a great deal of valuable preceptive comment, illustrating and illustrated by the buildings themselves that are spoken of; and even where they must be spoken of with censure, art and good taste are benefitted by the exposure of mistakes and errors. It is almost as necessary to know what we ought to avoid as what we ought to imitate; otherwise we have only one-half of the experience necessary for our guidance, and are in danger of running aground on the very same shoals that others have been wrecked upon, merely because the mistaken, not to say dishonest, lenity of biography and criticism has not pointedly marked out for our warning, those concealed dangers.

V. Not long ago a volume made its appearance, which promised beforehand to be an unusually complete piece of architectural biography, the whole of it being devoted to the life of James Gandon. As the subject of it could possess no interest for the general public, it was almost to be taken for granted that it would contain a great deal that would be particularly interesting to architectural readers. Instead of which, it has no interest at all for any one: as a biography it is a nullity, there being nothing in the history of the man himself but what might have been related in a couple of pages. His was not a life replete with incident like that of Benvenuto Cellini; neither is it made a vehicle for bringing us acquainted, except here and there merely nominally, with other individuals who were of particular note. The anecdotes with which the book is eked out, are all of the most trivial description; and

the notices of contemporary artists—nearly all of them, by the by, painters—are as dull as they are meagre, or rather are so meagre as to be almost of necessity very dry and dull also. The only one of whom we are allowed to obtain more than a mere glimpse, is Paul Sandby, who exhibits himself as a humourist, in which character he prepossesses us not a little in his favour in one or two very lively and playful letters—the only *bonne bouche* in the volume. As to Gandon himself, he might just as well have been any thing else—a builder or contractor, for instance—as what he was; and the book might still have been just what it is now. That he was an architect seems to have been all but entirely forgotten by his biographer. Though he did not erect many structures, those which he did were important ones; accordingly they ought to have been made the subject of full description and discussion: or if his works do not deserve it, but are as uninteresting as his own life, why should his biography have been attempted at all? At any rate, one work there is of his which would have afforded ample matter for notice, namely, the two supplementary volumes to the "Vitruvius Britannicus," for upon them might very properly have been founded a review of the state of architecture in this country during the period they illustrate. As it is, the "Life" of Gandon fully verifies the proverb, that "God sends meat and the devil sends cooks."

VI. Allan Cunningham's "Lives of British Architects," are just what they were intended, a few popular and pleasingly written biographies of the kind, derived from accessible sources, interspersed with superficial, and some of them erroneous, remarks, that may pass for very respectable second-hand criticism. With him, Vanbrugh the architect is eclipsed by Vanbrugh the dramatist. Allan contented himself with what he could find at hand and shaped out for him, without looking about for more *raw material*. James Wyatt is excluded, although he was most undeniably of extraordinary vogue in his time, and also in some measure makes epoch in his profession by having been one of the first to practise revived Gothic architecture to any extent. Notwithstanding, too, that he himself was a Scotchman, and not deficient in nationality, Allan gave us no biography either of Sir William Bruce, or Robert Adam;—and the omission of the latter is remarkable enough.

VII. If we turn to the continent, we shall there discover many important names that are now become available for architectural biography,—such for instance as Percier, Cagnola, Piermarini, Schinkel, and quite recently, Friedrich Gärtner. Of these, with the exception of the last, various memoirs, and some of them of considerable length, and critical as well as biographical, are to be met with in foreign publications; as are likewise those of a great many other French, Italian, and German architects. Most of them are quite as "well written" as Milizia's "Lives;" some of them incomparably better. As to Mrs. Cresy's translation of the latter, it is charitable to suppose that she was learning Italian at the time, and turned the book into English, for there are passages in it of which it is impossible to discover the meaning at all without referring to the original. Milizia required not a lady translator, but one thoroughly conversant with architecture, and capable of officiating as his annotator also.

HISTORY OF ARCHITECTURE IN GREAT BRITAIN.

A Brief Sketch or Epitome of the Rise and Progress of Architecture in Great Britain. By JAMES ELMES.

"Epitomes are helpful to the memory, and of good private use."

SIR HENRY WOTTON.

(Continued from page 210.)

The great epoch of modern architecture in England is that of Wren, and was created by the fire that reduced the city of London to a mass of ruins. Wren was fortunate in falling upon such an opportunity, and London was fortunate in finding such an able rebuilder as Wren, who was a singular combination of the greatest powers of the human mind. He was a scholar, a poet, an artist, an astronomer, a mathematician, an engineer, an architect, and a profound philosopher. Nothing was too difficult for his aspiring and powerful mind. He was born when Charles I. was in the zenith of his power, having then sat on the throne of Great Britain, as its second monarch, about seven years. How that monarch patronised architecture and the other arts of design is before recorded. Wren began his public career at a very early age; but, unlike the generality of precocious youths, retained his intellect unimpaired and his body vigorous to a Nestorian age.

He left Westminster school and was entered a gentleman commoner of Wadham College, Oxford, at the early age of fourteen. Although so young, he obtained the notice and friendship of the greatest men then resident in that university. The great mathematician, Oughtred, then a Fellow of Wadham, records his talents in his "Clavis Mathematicus," and Dr. John Wilkins, the then warden of his college, introduced him as a prodigy of science, to the Elector Palatine Prince Charles, who was on a visit to that distinguished seat and seminary of learning. He had previously known this illustrious Prince when on a visit to his father's house, the Deanery at Windsor, and took this opportunity of presenting some scientific inventions by the desire of Dr. Wilkins, and recorded them in a letter* to His Serene Highness. As a scholar, he was commanded by Sir Charles Scarborough to translate Oughtred's "Geometrical Dialling" into Latin, for the use of the learned men of Europe; and this when he was only in his 15th year. In the same year he invented and received a patent for an instrument for writing with two pens; and it is recorded as a singular coincidence that Sir William Petty, the founder of the noble family of Lansdowns, invented a similar machine in France, and obtained a patent in England in the same year with his youthful cotemporary. He was at the same period engaged by Dr. Sir Charles Scarborough as his demonstrating assistant in his lectures on anatomy, of which appointment he was so proud, that he communicated it to his father in a letter of elegant Latin. He also signalled himself as an astronomer, a scholar, and a poet, by a series of Latin metrical stanzas, proposing a reformation of the ancient fables of the signs of the zodiac; an algebraical treatise on the Julian period; and a Latin treatise on spherical trigonometry.

Few men of any time have exhibited a more expansive mind than Wren: like Michael Angelo, nothing seemed too great, too difficult, or too minute for its investigation. At one time sweeping the heavens with "Galileo's tube," tracing the motions of planets and comets through empyreal space; at another seeking the properties of insects and animalculæ with the microscopic lens; occupied in his study by storing his vast mind by the treasures of ancient lore; giving to the learned his discourses in Latin, worthy of the Augustan age; improving machinery for tillage, the mensuration of time, registration of changes in the atmosphere, and other useful projects. In fact, his mind was never unemployed; he studied, as Horace directs, by day and by night, and of no man could it be more truly said, *nulla dies sine linea*.

Whilst Wren was pursuing his course of studies and inventions with indefatigable industry, giving to the world useful discoveries at an age when others were studying their elements, a circumstance occurred that gave a powerful direction to Wren's mind. In 1648, Wren's 16th year, Pope Innocent X. announced to the world, that St. Peter's, the great cathedral of Catholic Europe, was then completed, under the superintendence of the illustrious Bernini. This great event was the engrossing topic of the day, and induced Wren, among others, to the examination of its claims to celebrity, by comparing it with the great works of the ancients and their architectural law-giver, Vitruvius, which was then a sealed book but to the learned. This new study enabled Wren, in after days, to complete our Protestant cathedral of St. Paul by himself, whilst that of St. Peter's occupied the talents of twenty architects, from Bramante to Bernini, including Raffaele and the mighty Buonarroti, who raised, as he had promised, the Pantheon into the air. Nineteen popes, from Julius II. to Innocent X., aided by forced contributions from the whole Christian world, raised the one: a single people, in three short reigns, by one architect, a single diocesan Protestant bishop, from no funds but those voluntarily given by the people, accomplished the other.

Wren's society and advice was sought by all the illustrious in birth and mind. His reputation was not merely British, it was European. At one time, he is sought by Helvicus to illustrate his chronological tables by an algebraical calculation of the Julian period; at another, invited by the illustrious Boyle to examine the hypothesis of Des Cartes on the pressure of the atmosphere, which indisputably gives to Wren the invention of the barometer; again, Dr. Willis desires his assistance in dissecting and preparing a treatise on the anatomy of the brain. Immersed in the numerous engagements consequent on being elected Fellow of All Souls, Oxford, and the preparation of an inaugural discourse on being appointed professor of astronomy in Gresham College, he found time to solve Pascal's problem, and to propound another, originally proposed by Kepler, and privately answered by himself, and was the only solution ever given to it. Hundreds

of such instances, in every branch of science, occur in his biography, from an investigation into the motions of the satellites of Jupiter, and as Savilian professor in Oxford to report on the constellation Taurus, to an earnest solicitation of his friend John Evelyn,* on the education of his son, to which Wren applied himself with as much sincerity and zeal as he did to the questions of the most learned in Europe, and to the king's command to make a globe of the moon. Sought for both in Oxford and in London, his presence at one causing regrets for his absence at another; filling with unexampled earnestness and zeal the astronomical chairs of the university and the metropolis, descending to them upon the starry heavens, and entertaining the members of the newly-formed Royal Society by microscopical disquisitions upon the smallest insects, and with ever-recurring novelties in mechanics, he still found time to cultivate the arts of design, and the still more abstruse science of chemistry, which he studied with other learned cotemporaries under the celebrated Rosicrucian philosopher, Peter Sthael, of Strasburgh, who was invited to Oxford and courteously entertained by the illustrious Robert Boyle, one of the closest and perhaps the most distinguished of Wren's friends.

At this period of Wren's life, his 28th year, which was marked by the restoration of monarchy in the person of the profligate and ungrateful Charles II., 1660, whilst he was filling the rich storehouse of his mind from every available source, had it been directed to any distinct object, whether in literature, philosophy, science, or art, he would have been eminent in either. From the circumstance of there being at that time no architect in England, but the neglected and almost forgotten Inigo Jones, he was consulted as a man of general knowledge upon all the little architectural projects of the day. Had Cromwell been a patron of the liberal arts, Wren, most likely, would have been his architect and surveyor-general, for it is related that Mr. Claypole, who married Oliver Cromwell's favourite daughter, who had more influence over her father than any other human being, was well acquainted with Wren. Claypole, who was a mild, retiring man, fond of mathematics and the studies of the closet, had a great love for the society of the youthful philosopher, and frequently introduced him to his own domestic circle, where the stern Protector occasionally paid visits to indulge in converse with his favourite daughter. It happened at one of these visits that Cromwell came into the room as they sat at dinner, and without any ceremony, as was his usual way in his own family, he took his place. After a little time, fixing his eyes on Mr. Wren, he said, "Your uncle has been long confined in the Tower." "He has been so, sir," replied Wren; "but he bears his afflictions with great patience and resignation."

Cromwell—"He may come out if he will."

Wren—"Will your highness permit me to tell him this from your own mouth?"

Cromwell—"Yes, you may."

As soon as Wren could retire with propriety, he hastened with no little joy to the Tower, and informed his uncle of all the particulars of this interview with Cromwell. After which the bishop replied, with warm indignation, that it was not the first time he had received the like intimation from that miscreant; but he disdained the terms proposed for his enlargement, which were a mean acknowledgment of his favour, and an abject submission to his detestable tyranny; that he was determined to tarry the Lord's leisure, and owe his deliverance, which was not far off, to him only.

That Cromwell did patronise Wren is clear, from a letter written by the latter to his friend, Dr. John Wilkins, wherein he states that his diplographic instrument, for which he had recently received a patent, had been "commended to the then great, now greatest person in the nation," (Oliver Cromwell.)

In 1661, Wren may be said to have commenced his architectural career, and to have fixed upon his future profession. He had completed his academical honours by receiving from his university the well-won degree of doctor of civil law. The king (Charles II.), who had acquired, both from his father and his sojourn abroad, a great love for the arts, finding on his return to the throne of his ancestors, how much the royal palaces, the cathedral of St. Paul, and other sacred edifices, had been dilapidated and desecrated by the military hordes of the Commonwealth, had determined on their restoration. Sir John Denham, author of "Cowper's Hill," who is more renowned for his poetry and polite learning than for any knowledge of architecture, had been appointed, in reversion, to the office of surveyor-general of his majesty's works, in reward for his loyal services, to which he had now nominally succeeded by the death of Inigo Jones during the interregnum. The fame of Wren had reached the ears of the king, who propos-

* Elmes' Life of Wren, Appendix No. 2.

* Author of the well-known Parallel of Architecture.

ing the reparation of St. Paul's cathedral, the re-instatement of Windsor castle, the building a new palace at Greenwich, and other important works, appointed him coadjutor to Sir John Denham.

Evelyn, with Sir Robert Moray, and other of Wren's most intimate friends and admirers, were upon terms of the greatest intimacy with the king. The former in his diary* ridicules the pretensions of Denham to the character of an architect, on consulting him, by the king's desire, as to the best site for the new palace at Greenwich, although he was assisted in his office by Webb, the pupil and son-in-law of Inigo Jones.

When Wren had held his situation of joint surveyor-general for about two years, the fortresses of Tangier and Tripoli having been surrendered by the king of Portugal as part of a marriage portion to his daughter, queen of Charles II., Wren was appointed to survey and repair them; but, preferring civil architecture at home to military engineering abroad, he respectfully declined the offer, which held out the promise of present reward and future favours, particularly the reversion of the entire office of surveyor-general upon the death of Sir John Denham. He therefore continued his designs for the reparation of St. Paul's, the reinstatement of Windsor castle, and other works, commanded by the king. He was also commissioned by the university to prepare designs for a new theatre, for the performance of their public acts, and exhibited a model of it to the Royal Society. This theatre, well known for its admirable roof and scientific construction, was the first public building erected by Wren, who was called by Dr. Sprat the English Vitruvius. It was finished in the summer of 1669, and opened by a solemn act of the university; its munificent founder and benefactor, archbishop Sheldon, who was then chancellor of the university, presented its architect with his highest commendations and a superb gold cup. He also appointed him, jointly with the vice-chancellor, perpetual curator of the fabric. The commencement of this edifice, the Sheldonian theatre, was commemorated by an elegant Pindaric ode, addressed and presented to Wren by his friend Corbet Owen, of Christ Church, entitled *Carmen Pindaricum in Theatrum Sheldonianum, et ejus Architectum*.

Wren's architectural employments increased with his fame, and he was required professionally in the sister university of Cambridge, to prepare designs for the new chapel of Pembroke college, of which his uncle, the bishop of Ely, had been president and a great benefactor. The first stone of this chapel was laid by Dr. Frank, the master of the college, accompanied by the dean, archdeacon, and prebendaries of Ely, Dr. Pearson of Trinity, and other heads of colleges, in the name of bishop Wren, who built and finished it at his own expense.

After making due arrangements for a temporary absence from his important avocations in England, he prepared for his long meditated visit to Paris and other continental cities of architectural celebrity. When in Paris, he writes to his friend the Rev. Dr. Bateman, "he was so careful not to lose the impressions of these structures he had surveyed, that he should bring away all France on paper." Of his skill in drawing there is abundant proof in the portfolios of his relics preserved in the library of All Souls college, Oxford, of which more may be said hereafter. To all his other knowledge, Wren added that rare quality of knowing himself. Although aware that he knew more of the theory of architecture than any other man in the country, he felt his deficiency as an artist. His mathematical and constructive knowledge was undoubted; but, as a fine art, architecture had not been cultivated in England, except by Wren's great predecessor, Inigo Jones; he therefore determined to read his Vitruvius amidst the ruins of the glorious edifices on which this master of our art had founded his precepts. According to this determination, he wrote to Dr. Bathurst, who was then consulting him about additions to his college, that as he was about to visit Paris he would consult Mons. Mansard or Signor Bernini. On reaching Paris, he was presented to the most eminent men of the brilliant court of Louis XIV., to whom he took letters of introduction from his illustrious friends in England. Architecture and its assistant arts flourished abundantly under the munificence of the French monarch and his sagacious ministers, Mazarine and Colbert. Paris, at that time, was the resort of all the distinguished artists and learned men of the continent, who formed a sort of congress, in which a man of Wren's distinguished abilities and reputation could not be unacceptable. The architecture of the French metropolis became an object of his peculiar solicitude, and he made himself acquainted with all that was remarkable in mechanics and philosophy. The ablest professors sought his acquaintance, and exhibited the newest discoveries to their English visitor; but architecture and its relative arts was his principal object. Among his own coun-

trymen in Paris, he found an easy introduction to the Earl of St. Alban's, then a distinguished patron of art and literature. Wren employed himself in surveying the most celebrated edifices in Paris and its magnificent suburbs. The Louvre was for a while his daily object, where no less than a thousand hands were constantly employed upon the works; "some in laying," he says, "mighty foundations, some in raising the storys, columns, entablatures, &c. with vast stones, by great and useful engines; others in carving, inlaying of marbles, plastering, painting, gilding, &c., which altogether made, in his opinion, a school of architecture, the best probably at that day in Europe." He adds that "an academy of painters, sculptors, and architects, with the chief artificers of the Louvre, meet every first and last Saturday of the month. Mons. Colbert, superintendent, comes to the Louvre every Wednesday, and, if business prevents not, Thursday. The workmen are paid every Sunday duly."

Wren was introduced to Bernini by the Abbé Charles; the illustrious Italian showed him his designs for the palace of the Louvre, and of the statue of Louis XIV., which he was then executing. He visited the splendid cabinet of the Duke of Orleans, and every thing that was rare and curious in Paris. In a letter to a friend he writes, that "he must not attempt to describe Paris, and the numerous observables there, in the compass of a short letter. The king's houses I could not miss; Fontainebleau has a stately wildness and vastness suitable to the desert it stands in. The antique mass of the castle of St. Germain's, and the hanging gardens, are delightfully surprising (I mean to any man of judgment), for the pleasures below vanish away in the breath that is spent in ascending. The palace, or, if you please, the cabinet of Versailles, called me twice to see it; the mixtures of brick and stone, blue tile and gold, made it look like a rich livery; not an inch within but is crowded with little curiosities of ornament. The women, as they make here the language and the fashions, and meddle with politics and philosophy, so they sway also in architecture. Works of filigree and little trinkets are in great vogue; but *building ought certainly to have the attribute of eternal, and therefore the only thing incapable of new fashions.*" On this opinion of Wren, Mr. Seward makes the following remarks, which cannot be too much attended to by every architect and every architectural student of the day. "Many of the buildings which have remained to us from the ancients are universally allowed to be perfect models of the art of architecture. In spite of the rewards offered by sovereigns, and of that innate desire of man to do something more and better than his predecessors have done, every attempt to add another order of architecture to the five long since transmitted to us from the Greeks, has been vain and fruitless, and has in general effected nothing but a variation on the Corinthian order. The art of building, being an art of which the constituent parts are utility and beauty, must have soon arrived at its point of perfection. We have but little left to do but to arrange and compare. What has the rage of inventing in architecture produced in our times? May-poles instead of columns, capitals of no order, and adjuncts and decorations so whimsical, so minute, so split into small parts, tortured into grotesque forms, that, as Lord Bacon observes of plots in gardens, 'you may see as good sights often in tarts.'"^{*}

Wren was far more pleased with the Mazarine palace and its splendid collection of antique statues, bust and other marbles, pictures, gems, and other curious articles of ancient and modern art. Not a palace or a villa, or any building worthy of note, escaped the attention of Wren, who surveyed them with the investigation of a student rather than the casual visit of a passing traveller; he made drawings, sketches, and memorandums of every thing that tended to his great object, the improvement of his knowledge and taste in architecture, and spared neither labour nor money to fill his portfolio. In the same letter from which these remarks are taken, Wren emphatically adds, "Bernini's design of the Louvre I would have given my skin for, but the old Italian gave me but a few minutes' view; it was five little designs on paper, for which he hath received as many thousand pistoles. I had only time to copy it in my fancy and memory, and shall be able by discourse and a crayon, to give you a tolerable account of it." Beautiful as was Bernini's design for the Louvre, it was rejected by Louis XIV., in favour of Perrault's present façade and its novelty of coupled columns, which must have had some influence upon Wren's mind, as he introduced a similar arrangement in his second and inferior design for the western portico of St. Paul's cathedral.

Among the eminent artists whom Wren met in the academies and societies in Paris, he mentions Bernini, Mansard, Vaux, Gobert, and Le Pautre, as architects; Le Brun, Bourdon, Poussin, Coypel, Picard, and others of less note, as painters; Anguere, Sarazin, and Perrot, whom he commends

* Evelyn's Diary, Vol. I. page 341.

* Seward's Anecdotes, Vol. II.

as famous for bassi rilievi; Van Ostal and Arnoldin, who executed the beautiful plastic ornaments and stucco work in the Louvre.

Wren returned to England in the spring of 1666, to arrange his multifarious business previous to his intended visit to Italy, and the records of the Royal Society and Gresham College, and the reports of Boyle, Evelyn, Hooke, and other philosophers with whom he was associated, prove how laborious and important they were. The fire of London detained him in his native land, from which he was never after absent. He resumed his labours in the restoration of St. Paul's, which had been plundered by the Oliverians, its monuments desecrated, and its choir converted into barracks and stables for their horses and troopers. The great fire, however, put a stop to this and other of Wren's employments in the city.

Before Wren's visit to Paris, he had been consulted as to the additions to Trinity college, Cambridge, which he completed so effectually as to elicit the following just encomium from an eminent historian, Dyer, of that university. "Such as know," says this author, "how favourable architecture has been, and still is, to the accommodations and conveniences of life; who have followed its progress from Egypt to Greece, from Greece to Rome, and thence to the states of modern Europe; who have studied the proportions, the appropriate decorations, nice arrangements, and the gradual intermixtures of the Grecian orders, might make a study of this spot. Here it was our great master of Palladian architecture, Sir Christopher Wren, surveyed his own work, and was satisfied. Any artist, too, might linger here long; and, with a proper exercise for his taste, might receive peculiar delight and proportionable improvement."

The preliminary works had been proceeding during its architect's absence; and he recommenced his work, on his return, with vigour. The beautiful western quadrangle, called Nevile's court, from its splendid benefactor, Dr. John Nevile, was then considered an example of excellence in architecture. The celebrity of Wren's works at this college have been considerably enhanced by the recent visit of the Queen and her royal consort, on the installation of the latter as chancellor of the university, and of the magnificent public breakfast given to these illustrious personages and their court, by the master and fellows of this munificently endowed college.

The following letter, transcribed from the three folio volumes of manuscripts and drawings, in All Souls college, Oxford, which the author of this paper copied during his sojourn at that university, for the purpose of collecting materials for his Memoirs of Wren, gives a fair insight into his character as an architect, and of the difficulties with which he had to contend. It contains explanations of six designs for various parts of the collegiate buildings, from which a few extracts may suffice to show how very particular this great architect was in the details of his designs. He informs his correspondent that "a building of that consideration you go about, deserves good care in the design, and able workmen to perform it; and that he who takes the general management upon him may have a prospect of the whole, and make all parts, inside and outside, correspond well together, to this end I have comprised the whole design in six figures." He then describes, in a minute and plain style, each of the six designs, such as the construction of the walls and staircases, the arrangement of the library and its shelves, and the subdivision of its walls and ceiling with pilasters and panels, so as look best, as he says, in perspective, of which science he was a complete master. He presumes they have good masons, yet, that there may be no mistake, informs him that he shall send drawings of the mouldings the full size. He apologises for his minuteness by stating, "we are scrupulous in small matters, and you must pardon us; the architects are as great pedants as critics or heralds."

Within two years after the fire of London, Wren was employed as architect by all the chief authorities in the kingdom. He brought his great work, the Sheldonian theatre at Oxford, nearly to a close, which was opened, as before mentioned, with great ceremony; and commenced the chapel of Emanuel college, Cambridge, under the auspices of his munificent friend, Archbishop Sancroft. This edifice is of the Corinthian order, two three-quarter columns *in antis*, an arcade between them on the ground floor, and the chapel, with parallelogrammatic windows between the columns. The necking of the capitals is continued on the walls, and the space between it and the architrave decorated with festoons. The pediment is broken by a clock, the frame of which forms a pedestal for the bell-tower. It is not in Wren's best style.

Of Wren's works other than those he executed in the metropolis, were the royal hospital for invalided soldiers at Chelsea, that for sailors at Greenwich, the Observatory or Flamstead house at the same place, the chapel of Queen's college, Oxford, a palace for Bishop Morley, who had accompanied Charles II.

in his exile, and a royal residence at Winchester for the king, who liking the situation of this city, selected it for a private occupation, when not required by affairs of state to be in London. Winchester had been much destroyed by the parliamentary forces after the battle of Naseby; as had been also the neighbouring city of Chichester. Their cathedrals, however, met a different fate, for whilst that of Chichester was much destroyed and made into barracks for the troopers, that of Winchester was preserved, by the filia care of Sir William Waller, who having commenced his education at Winchester school and finished it at New college, Oxford, saved the cathedral of his beloved *alma Mater* from its intended desecration by his soldiers.

For these reasons, the king desired Wren to prepare a design for a royal palace. Its extent to the west was 326 feet, and to the south 216 feet. Had the entire design been completed, it would, with its contiguity to the New Forest, and to the sea at Southampton, to which the river was to have been made navigable, have been one of the finest hunting palaces in Europe. The marble columns for the great staircase were presented to Charles by the Grand Duke of Tuscany. It stands upon a beautiful rise above the city, and is still known by the name of the King's House. It was used as a barracks for infantry during the French revolutionary war. Among Wren's other provincial works, was the Ashmolean Museum, at Oxford; many reparations at Windsor Castle; the large additions to Hampton Court palace for William and Mary, who held Wren in as high esteem as did any of their predecessors; Morden College, Blackheath; Isleworth Church, near Brentford; two handsome mansions in Chichester, faced with red brick, and stone architraves to the windows, and finished with a Corinthian modillion cornice, much resembling the one near the south-west angle in St. Paul's Churchyard, also by him; the reparation of Chichester Cathedral, that had been destroyed by the republicans, and the rebuilding of the greater part of its spire, which is remarkable for the pendulum stage that he had fixed therein, to counteract the effects of the south and south westerly gales of wind, which act with considerable power against it, and had forced it from its perpendicularity. By the ignorance of the workmen who had the care of the cathedral prior to 1811, this stage had been made a fixture, and considered to be only a scaffolding for the support of the external masonry. This error had again occasioned the spire to deviate much from its perpendicularity, and become consequently fractured. Sir Christopher Wren had carefully marked upon a brass plate in the nave the true centre of the apex of the spire as he left it, and from which it was found it had inclined considerably towards the north-east. It was taken down and rebuilt, with a perfect restoration of a new pendulum stage, affixed like the clapper of a bell to the finial that carries the weathercock, at the expense of the dean and chapter of Chichester, by the author of these columns, in 1813-14.

This article being a brief summary of the history of architecture in England, and not a biography of all its architects, it is sufficient to say of Wren, that he was honoured by his sovereign with knighthood, with repeated appointments under the great seal of a royal commissioner for the rebuilding of the city of London, the Cathedral of St. Paul, the restoration and reparation of Westminster Abbey, and other public works. By his brother philosophers he was elevated to the president's chair of the Royal Society; and was twice returned to parliament by his fellow citizens. Although Wren commenced his public career at the precocious age of fourteen, he lived in the enjoyment of bodily health, mental vigour, and public employment, to the extraordinary age of ninety-two, when he left this world so quietly, that he can scarcely be said so much to have died as to have been missing from his extensive stage of worldly employments.

His great works in the metropolis are too numerous, too evident, and too recent, to need description in a brief memorial like the present. Let it suffice to say, that had the city been laid out entirely by the plan suggested by Wren, it would have been the finest and healthiest in Europe. The best parts—that is, the situation of the public buildings—are Wren's; and the meaner parts—that is, the lanes and alleys, many of which have been recently improved—were the production of the avarice and haste of the citizens. All the parish churches, the companys' halls, many of the mansions of the merchants and aldermen, the Royal Exchange, the Custom House, and other minor buildings of the city, were the productions of Wren's genius.

Wren, in his St. Paul's, the most splendid of modern buildings, has powerfully exemplified that just and effective imitation which is essential to the character of a pure style in architecture; and, at the same time, leaves room for all the exercise of legitimate invention. St. Paul's is such a free imitation of St. Peter's as the *Æniad* is of the *Iliad*; and elevates

its illustrious architect, whom the *Quarterly Review** calls "the pride and honour of English art," to the rank of an equally bold and original imitator, as Milton is of Homer and of Virgil; exhibiting in all its parts the most indubitable marks of real genius—"that quality, without which," says Dr. Johnson, "judgment is cold, and knowledge is inert; that energy, which collects, combines, amplifies, and animates."

* For October, 1822.

(To be continued.)

GLANCE AT SOME OF THE ATTRIBUTES OF ARCHITECTURE.

By FREDERICK LUSH.

No. II.

"Greek art had her infancy, but the Graces rocked the cradle, and Love taught her to speak."—FUSSELL.

Simplicity, &c.—We cannot arrive at conclusions respecting the first principles of art, without making the human mind, as being the source of all beauty, the groundwork of our investigations. All the qualities that contribute, or are essential, to artistic beauty, will be found to make up the requirements of a perfect mind; and among these qualities, that which bears a very striking analogy to it, is simplicity.

Simplicity and unity of composition may be compared to that power of generalization which selects from dissimilar objects, parts of a like nature or property, and then includes them under one genus or kind. It was a principle of the Greeks, which was founded on the idea they formed of perfect nature, "to combine into one grand expression of feeling a whole series of ideas, and by excluding everything heterogeneous, to combine all homogeneous elements into a perfect and harmonious unity" (Schlegel*). Amidst, therefore, the many and varied elements of an art, whose grand object is to make a strong impression on the senses, no matter that is irrelevant must be allowed—nothing that would produce confusion; so that the eye may repose upon it without the least distraction: the various ingredients being so balanced and regulated, that not one of them shall act prejudicially to the rest by any undue proportion; but that each combine, to the utmost of its power, in such perfect unison and co-operation, as to conduce towards but one end, and announce in its effect the one great controlling mind that directed and presided over it. This is so necessary, that even where the style of architecture is elaborate and intricate, it must still preserve a marked unity and consistency of purpose, for without it we may not be enabled to see and embrace clearly the complication and web of the whole. In simplicity, a degree of variety and contrast must be joined to it, lest it should be too monotonous and betray a poverty of imagination; variety also, uncomposed and without some simplicity and consistency in its parts, would withdraw the attention from it on account of the appearance of confusion.

Those ancient temples, which in their plan and general forms were parallelograms, and offered a most striking similarity and uniformity of parts, suggested to the spectator ideas of infinity, notwithstanding their extreme regularity. But the gratification which the mind receives from objects, depends upon the nature of the exercise they afford to the visual faculty; and circular forms, in consequence of bringing all the muscles that move the eye into play, causing an equable share of labour, are found to yield more delightful sensations than those produced by objects bounded only by straight lines. Now, a knowledge of the effect of geometrical figures was known to the Greeks; and we have a fine instance of their appreciation of the circle, in the Choragic monument of Lysicrates. In this rotund temple, as in many others, we may notice that the figures in succession in the bas-reliefs on the frieze, seem to the eye to have no limitation, but as it advances and one portion appears, another disappears; so that although the whole is most simple and uniform in itself, and may be easily embraced at a glance, yet at the same time it seems endless and infinite. This beautiful idea was imitated by the Romans, but its elegance and grace was lost in vastness of dimensions; for grandeur emanated from them as beauty did from the Greeks, and proofs of their masterly

control over the arch and vault, which they were ever ambitious to display, remain to us in their Aqueducts, in their Pantheon, and Castle of St. Angelo. So the classical mind of Bramante, soaring and expanding itself in the contemplation of circles, in conceiving a design for St. Peter's, suggested "for the naves, an adaptation of the arrangement of the great arches in the ancient edifice called the Temple of Peace; and for the conjunction of the four naves, the construction and form of the Pantheon:" thus uniting and harmonizing in one stupendous structure the proportions of two of the grandest edifices of antiquity.

Simplicity is the leading characteristic of Grecian architecture. The form of their temples was the simplest, although in its details the most elegant, and in its dimensions the grandest, that could be conceived—gracing the sites on which they were erected; for there seemed to exist among the architects a sort of anxiety lest they should in the smallest degree disfigure nature. The orators and philosophers of the day beheld in them the image and reflection of sincerity and truth; and the aspiring columns, no less than the graceful superstructure, were channels for conducting minds habitually soaring, to the contemplation of supernatural beauty. At the glorious epoch of the Parthenon, the porticoes being the favourite places of resort, a building would scarcely have been tolerated that was not stamped with that calm repose, that dignified simplicity, which most assimilated with the feelings of the Athenians. Hence the sedate grandeur of expression which breathed from their walls, which led the thoughts upward, and was eloquent not only with the authoritative voice of the senate, but with the stern wisdom yet mild tranquility of the deity to whom it was consecrated. The presiding goddess of Athens was the muse that aided them, the fount whence they drew their inspiration.

The Greeks prided themselves upon the invention and perfection of their columns, and since they made them perform such an important part in their edifices, they took care to set off their contours and proportions to the best possible advantage. With what success they did so, we have proofs in the impressions conveyed to us by some of the porticoes of their temples—as that of Minerva, where the utmost relief and effect are given to these features, by the majestic shade which is flung into its intercolumniations. Here, it may be remarked, the *chiar'oscuro* is not broken up and minute, but the light and shade of the structure presents broad and simple masses.

The most cherished objects which the sculptor could commemorate on their temples were the deeds of conquerors and heroes; but then there was demanded on his part a high command of talent, that such things should be worthily represented; and that, by a scientific and beautiful execution, by force of expression and simplicity of character, they should be at the same time a powerful auxiliary to the architecture. Viewing sculpture in the days of Phidias, we cannot but be struck with its admirable harmony to the grand and simple character of the temple. The high embellishment and importance which it received from the introduction of sculpture, is particularly observable at that epoch; and it is only by an attentive examination of the bold and decided execution of the ancient reliefs, so adapted in their effects of *chiar'oscuro* to their elevated positions, that we can appreciate the excellency of the principles which regulated their introduction into the buildings—principles often inculcated and taught by the philosophers, and founded on a profound knowledge of optics and perspective.

In the materials and means employed, as well as in the forms they selected, we see how wisely they sought and secured simplicity; they adopted just so much as the peculiar nature of circumstances prompted, and no more; they produced the greatest strength with the fewest materials—the greatest effect with the simplest means; they brought out the most beautiful features into the strongest relief; they mingled the *utile cum dulci*; the elongation of lines and the relation of spaces satisfied the mathematician,—the delicacy of the curve delighted the poet; the uniformity and succession of parts, the huge masses of the surfaces, the long unbroken continuation of the members, all tended to produce sublimity and breadth of manner; the ornamental portions softened the aspect, and prevented too great a degree of austerity: yet, in the sculpture there was no artificial refinement,* no laborious minuteness, but it contributed to the stateliness of the pile; and even when the Greeks thought it necessary, under their glowing sky, to heighten the effect of the whole by the addi-

* Lectures on Dramatic Art and Literature.

* The Elgin Marbles.

tion of pigments, still its moral grandeur rose paramount to all the brilliancy of colour. Owing to the searching and penetrating light which shon around it, anything that was defective would be immediately manifest—the beauties more strongly developed; so the utmost ingenuity of the artist was taxed to combine greatness with caution, effectiveness with economy: if the colouring, for instance, were over-warm and not judiciously applied, a glaring contrast might be produced; equal care was necessary, also, lest it should be too cold, amidst the variegated and luxuriant scenery by which it was surrounded. On the same principle, nothing unnecessary or superfluous was to obtrude itself in the ornamental portions;—what took the lead in these were the sculptured figures, that represented various actions, and gave the most animation to the marble—on the execution and arrangement of which, mature consideration was to be bestowed, a conspicuous situation being given to the principal: to conclude all, the building, by its pyramidal termination, was brought to an exquisite climax.

This supremacy of grandeur over the desire for the exhibition of ornament—this mastery of simplicity over every inferior feeling, convinces us of the high taste and refinement of the Greeks. They attempted, but indeed were able, to achieve the sublime. They knew that art could only possess the efficient cause of the sublime, in proportion to the manifestation of skill and manly energy. They knew that a departure from simplicity would be a fatal blow to art: and hence it was that the legislature watched over its interests, and Pericles enforced upon the artists the necessity of preserving in all their works a settled simplicity, as the principal source of grandeur. And there is in simplicity of architecture, especially in that so deservedly called "Classic," an attraction which calls forth a dignified calmness, yet a tenderness of soul, and steals upon its sympathies as does the pure and unsophisticated nature of a beautiful child. Hence the dominion of the architecture of the Greeks over our feelings—for the evidence of what is truly good or beautiful, is recognised by the soul as something most congenial to it; and that unity of design, that conformity of character, in Grecian architecture, corresponds in its nature to that of a well-regulated mind—to the healthy balance and proportionate development of all the powers that constitute a perfect nature. Architectural works that bear not this stamp cannot satisfy. Such are those where we see the imagination has gained an entire ascendancy over reason, and where an overweening fondness for a redundancy of ornament has been indulged in at the expense and sacrifice of simplicity.

THE BRITISH MUSEUM.

No. I.

The opening of the new hall of the British Museum is a fitting time for beginning a set of papers on its contents in this Journal, in which we have very often given notices relating to it. The collections in the British Museum are more the result of the exertions of the public than of the government, and unless the exertions of the government be kept up by the voice of the public they will be slackened. Great as is what has been already done, yet measured by what is wanted and what is to be done, it is but little. As the public get a better knowledge of the Museum, and make a better use of it, so they prepare themselves for the requirement of something more. We fear, however, that the worth of the Museum is not yet so fully felt as it ought to be; while we cannot but say, that even in its most trifling uses its worth is great.

By some, the Museum is looked upon as a great plaything or playhouse for the people. Be it so; we should be willing to take the matter on that footing, for it is no mean thing to furnish pastime for a people. Among the chief duties of a government, are to provide for the amusement of the people; and if men who are hard-worked in their several callings, can have a day's pleasure in a Museum, and can have given to them new thoughts, which shall fill their minds in many days of toil, this is a great thing. Discontent is one of the greatest evils which any government has to withstand, even where bodily evil, hunger, and want are not felt. The gloomy sway of the Independents broke down mostly from this cause; and the people hastily changed a good government for a bad one at the Restoration, because they were deadened and disheartened by the want of their accustomed pleasures. The playhouse, the bear-garden, and the fair

were closed, the fiddler and the ballad-singer were put down, holidays were forbidden, and although plenty reigned at home, and glory crowned our arms abroad, the people were sullen and unhappy. In times of want, workmen are ever open to be led astray by mob orators and agitators, to whom, when in full work, they will not listen. As it is with one, so it is with many; when the mind is heavy and the heart faints, the man himself gives way to a trifling sorrow, and sinks from bad to worse; whereas, were he but upheld, he would overcome every hardship. More or less, the same thing is to be seen at all times, and we feel sure that we are always doing good when we are yielding pleasure to the old or to the young. Happy feelings are the mainspring of good deeds.

As it has been acknowledged by the greatest statesmen, that it is desirable to find pastime for the people, so it should be given usefully. The bloody shows of gladiators, or the beastly games of the bear-garden or the prize-ring, will give pleasure to those who are called enlightened Romans or enlightened Englishmen; the gambling cock or quail fight or horse race may prove still more enticing, but no one good feeling is awakened or strengthened, and no bad one weakened or quelled. The love of the good, the true, the great, and the beautiful is that which should always be kept before the people, from their childhood to their death, in all outward forms and shapes. It should never be thought that education is the time of schooling in boyhood, but it should be remembered that in its rightful meaning of "bringing up" a man, it is being carried on at all times, in all places, and by all means. The eye, the ear, the touch, the taste, the smell are always on the watch learning something,—and if not good, they are learning evil. Thus habits, which cannot be shaken or undone, are shaped slowly and unknown, and fetters are welded which chain the mind in the doing of good or evil. If mankind are to be thoughtful and careful in their deeds and thoughts, it is becoming that in everything we should keep sight of goodness, of truth, of beauty, and of greatness, for the Almighty maker of all has done this in everything, from the smallest being, hardly seen by Ehrenberg under the most powerful microscope, to the great bulk of the mastodon or the most dreaded beast which ever walked the earth. If mankind are not to be taught to think, at least, we should take all means of giving them right habits.

Whatever may be the feeling as to the forms of worship to be taught in common schools, however much quarrelling and bickering there may be about these—whereby the children of England run the chance of losing their schooling altogether—there can only be one feeling as to the right and duty of the government to look after the public bringing up of the people, by training them to proper thoughts, wherever there may be the means of doing so. No one, we believe, has ever thought otherwise than that the great mind of the Greeks, their love of freedom and of learning, was kept up as much by their care for the beautiful in their buildings and public works, as by any other means. Those lovely temples, those carvings which have never yet been outdone; those shapes, which seem already to have a soul, and want only breath to live, were but the outward showing of what the minds of the people held within, of those great feelings of which even the lowest Athenian slave must have had his share.

If we are to have great public buildings and great architects, we must have an enlightened people, a people who love art for its own sake. In Athens, lowly as were the dwellings, every public building was beautiful, and was so because no other dare be opened to them. Public buildings are always those which are the best for showing the skill and cunning of the builder, where there is the most money to be laid out, the best place to be had, and the most care to be taken in keeping up what is once built. In London, not to say in England, so far from our public buildings being always handsome, they are often far from it; and what a single rich man would not bear nor lay out his wealth upon, many thousands of the people are made to bear. It is a mere chance whether Wren or Dance be the architect, whether he be Barry or Soane. We should never see work-houses set up for public buildings, and barns for churches, if the people were brought up to think rightly. The taste of a people may wander upon matters of detail or of style, but it is always right as to what is great or beautiful. York Minster, St. Paul's, and Westminster Palace will always be liked by the people, although they may never be able to give a reason for their liking.

It is acknowledged that we have made a great step in weaning the people from cockpits, bear-gardens, and prize-fights, that we have lessened their love for low and bloody sports,—and we feel a kind of pride that we have done so much. We may be no less proud that we have given them a greater love of gardens, paintings, and museums, which, while we look upon only as a harmless change, must indeed work greatly upon the minds

of the people. The lessening of drunkenness and idleness, the milder bearing of the people, the falling off of street fights, the greater cleanliness and neatness, if they lead to better health, are of still greater worth, as they lead to better minds. If we teach a workman to like the museum better than the alehouse, we teach him something more; by awakening his thoughts as to what is only rare, we awaken his mind in his own calling, and the thinking workman must be a better workman than the unthinking workman. There are, however, many callings in which the workman has to deal with shape and colour, and if his thoughts are in any way trained to see and feel what is beautiful, he has earned something which to him is of the highest worth.

That the people of England are not brought up to have a right feeling of the beautiful and great in works of art, is seen painfully, not only in our public buildings and in our shows of paintings, but also in our workshops. Whenever this has been looked into, there has been but one answer by men of skill and knowledge, whether English or foreigners, and that is—that the English people and English workmen have less taste than those abroad. This is the pain whereby carelessness of a natural and moral law is made known, and those who judge by the purse are punished in the purse. The price we pay for foreign silks, satins, ribbonds, lace, clocks, watches, castings, jewellery, paper hangings, made flowers, and other wares bought of the French, Flemings, Swiss, Italians, and Prussians is so great, as to be a wonder to those who reckon it up, and bethink themselves that England is the great loom and workshop for the world, the heart of trade, and the mistress of every craft whereby wealth can be made. We pay down in hard money a heavy fine for our want of learning; but this is not the only loss to which we are open, for we further lose the supply of foreign markets, which, if we tried in the right way, we could master, as we do all things that we once try. This is a money reason, and a weighty one for a love of art.

We cannot foster the love of the beautiful and great in art, without fostering the love of the true and the good. It does not follow that a painting, a carving, or a building shall be all truth and nothing more, but there must be something which shall strike the mind as true; and though with this it will take in much which is untrue or false, yet without some truth is mixed up, it will not take in any share of untruth. In a building, this seeming of truth may belong to the look, as, if a prison were built as a playhouse it would not be liked, neither would a playhouse if built as a church; so, too, if a building were so made, that it seemed unsteady or toppling, there would be a want of truth about it which would strike any man. In a play or in a painting, it is acknowledged that there should be this truthfulness, which when once given in the leading parts, the looker-on is willing to take the stage or the canvas as the real scene of the events, and to overlook the want of solidity in the colours, or the smallness of the drawing—nay, to go in despite of his own knowledge that the player is Jack Robinson, and believe him to be Alexander or Henry the Fifth. It is, perhaps, a failing of mankind, that a small share of truth is often enough for them, and that having that, they do not look further; but as in works of art they are trained to look for the true, so is the love of truth upheld; and the eyes of the looker-on being opened, and his mind awakened, it cannot be otherwise than that he should get a greater love of truth, and that it should follow him in his life.

The truthful in art is its groundwork, and carelessness as to this is a besetting sin of our artists, and therefore they do not carry the people along with them. The painter makes a show of bright colour, and thinks he does enough; the architect puts in good stone and good mortar, and then prides himself that he has done all. "*To kalon kai to prepon*,"—the handsome and the fitting—was the good rule of the Greeks in art; so likewise did they say "good and beautiful"—and, indeed, in a few words, they teach the whole sum of art. With a better trained people, we should have better drilled artists, for these latter would no longer dare to set themselves against all right laws, and waste their own powers and our means. The new school of art must be made from without, and not from within; it must, as with the Greeks, not depend upon the few of the artists, but upon the firm will of the many. Although Pericles took the lead, the Athenians never forsook the path in which he had led them, and the whole commonwealth took its way onward. On the other hand, single lovers of the arts die, and the arts die with them. The wealth of the Philips gifted Spain with paintings, but not with painters; Charles the First died before he had awakened a love for art in England; but if Lewis of Bavaria dies, the school of Munich will live in despite of charlish followers. Lewis has not merely bought paintings, but he has raised up a school of artists, who are already sought throughout Europe.

Where the love of the beautiful is strengthened, the mind likewise is strengthened, for it takes a healthy action instead of an unhealthy one. Discontent is one of the worst signs of a low state of being, as is seen in Ireland, where what is good and useful is altogether lost sight of in brooding over fanciful ills. A healthy mind is ever ready to draw the most good from everything: an unhealthy one to draw the most evil. So in criticism this may be seen; while the older, higher, and better taught critic is ready to find whatever is good, the younger and worse trained critic thinks he does best if he can hit upon a blot—which moreover he is sure to be able to do in any one of man's works. These must always be faulty from their very beginning: we know this, and it needs small skill to show it; but every one is not well enough trained to find a beauty and to feel it. How often is it found that an old and great painter will find a beauty in the work of a younger man, for which the brethren of the latter give him no praise, but the rather run him down for his faults. The greater our knowledge, the greater our pleasures; it is not, as is thought by some, that the round of our pleasures is hemmed in by our greater knowledge, but that the more we know, the better our feelings are trained, the greater love do we get for what is good and right, and the less we care for what is bad and wrong.

The kind of schooling which has been most used by enlightened people in olden times and in new times, has been such as to open the minds of youth to the great principles we have named. The teaching of Homer among the Greeks and Romans, and of the Classics among ourselves, better answers to a liberal, free, and easy way of training, than does the drier way of mathematical study, which there are many people who now uphold. In schooling, what is taught is less to be looked at than how the mind is trained, for the man of hereafter will not be made by a faultless knowledge of English grammar or an exact and correct way of reckoning, but by those powers of mind which will enable him to do his part among his fellow men. Public training should be in agreement with that of the schools—the man should be able to follow up what he began as a child; or if, as a child, his training has been careless, there is the more need that it should afterwards be in a right way.

We have thought it right to stand up for the British Museum, as a school for the people, inasmuch as the matter is little understood, and many able men are very careless about what so far from being a trifle is a thing of very great earnest. In whatever light we look at the matter, if we choose to think, we are always brought back to the same point—that the public training of the people in the right way is of the highest need, and that a museum, well laid out, is among the best schools and best means of doing this. Indeed, we have no fear in saying that every pound laid out in the British Museum has been already brought back by what we have earned in our workshops, to say nothing of the very great good which is done to the minds of its hundreds of thousands of yearly visitors.

It is pleasing to see that the part of the Museum given to olden art is now large and well provided; but it is not laid out as if those at the head of it had a clear sight of what it ought to be. To gather bit by bit works of art here and there, is not enough for any end of public teaching. The more the Museum is made useful, the more its worth will be felt, and the more will be done to make it greater and better. Although the Museum holds the works of many people, it neither gives any full view of the works of one people, nor of the way in which art has grown and been followed up. It is wanting as a whole, and the feeling made is that it is a gathering of bits of wreck, worthless to their former owners, and of which the now owners do not know how to make use. This is not to be said of all to the same length; but it is to be said, more or less.

Although the Greek rooms hold the Phigaleian and Elgin marbles, and have many later works of worth, they give, even to the scholar, but a small knowledge of what Greece and Greek art are; they rather want the book to help them out, instead of helping the book out. There is an earnest, it is true, of the will to do and of what may be done; but we want a great deal more. When a working man has seen all the marbles of the Parthenon, he has no better thought of the Greeks than he had before. The Egyptian rooms, which are much better off, will teach him much more as to the Egyptians. The letting in of some casts from the Parthenon, of the casts from the Egina marbles, and of the models of the Parthenon, have opened the way for more. We would have the Greek rooms laid out with casts from other museums of the works which are missing here; there should be models of such temples as can safely be laid down; likewise models of tombs. In the Greek rooms we would place the vases, bronzes, and coins. Why these are put away we do not understand.

Models would show the great buildings of the Greeks, from which would be seen the originals, which have been so much followed in late times. To the lower classes of builders, to masons, and to workmen, this would be of much use. We are sure that the model of the Parthenon has already done a great deal of good in showing to the people how a public building of this kind was treated at Athens. The peristyle, and the marble carvings, go far beyond what we are here pleased to call Greek architecture. With a better knowledge, of such things we should not be waylaid with brick barns stuck on to a small portico, or with porticos, so called by their makers, from being made with a few naked columns which but for the capitals dare not be called Greek or anything else. If the growth of Greek building in England be desirable, nothing is more likely to further it than a knowledge of it in its best shape.

The bronzes and a few more casts would enable us to follow Greek art from its beginning, and this is most useful. In the Eginetan marbles we have rude and grim drawings of men; in the Phidian we have gods in the shape of men. We can see how art began, and how far nature truthfully followed will lead us. The Greek carver learned from the living man, the carver of this day from a cast, the pattern drawer or bronze founder is taught in a school of design from a drawing of a cast, in which life has been so wiredrawn that it has fluttered away. Going into the Egyptian room we find in the best figures a careful anatomy in parts, but that the carvers, having stopped in that path in which the Greeks went on, never reached the power of the latter.

The works of the failing time of art teach likewise, and we can track the footsteps of failure from their first faint marking. When the carver set up the great works of old as his model he began to waver, and though he might bring forth a great work, yet he led those who followed him off the right track; so that in the end nature was forgotten. Whatever may be said, the living form is our nearest and surest inspiration, it gives us a nearer insight into the workings of the divine power, and we cannot therefore in art get better teaching.

The vases, showing how in the household, and in those things most brittle and most worthless, the principles of art were followed by the Greeks, should stand in the neighbourhood of the lasting remains of the Parthenon. It is by seeing the Greeks in small things as well as in great, that we are led to acknowledge the depth of their feeling for art and learning, upheld at a time when the printing machine was not, before the telegraph overcame time, or the railway lessened space. The schooling of the wealthiest Athenian was behind that given to a foundling in an English workhouse; but how much is England behind what Athens was in art!

The coins, which are now hidden, and about which it may be said no one knows anything, should be drawn forth. They will be as safe under the public watch, as where they now are.

The Egyptian rooms, and even the Etruscan, are in a better state than the Greek, and we have therefore not so much to say about them; but in the Egyptian rooms, models might well be placed of the pyramids, temples, obelisks, tombs, sphinxes, and great works. Now, we only see the little works of the Egyptians, their skill in handicraft; but we should have some knowledge of those great works, which have been the wonder of so many ages.

The Roman rooms give us a very poor knowledge of a people who, by their writings, are better known to us, and who have this claim—that they peopled this island before us, and that our English forefathers fought with them. A very great deal must be done before the Roman rooms will be what they ought. Among other wants we may name copies of the frescoes from Pompeii.

The Welsh or British antiquities should be put in order, so as to show us the state of the savages who filled the island before the English overcame them. The few models of cromlechs were a useful addition, but all such things should be modelled, and the works of the Irish and of the Welsh in Gaul should be shown.

The English antiquities cannot begin with any works of our forefathers in Scotland, but a collection should be formed which should include tombs, brasses, armour, weapons, coins, seals, models of buildings, books, paintings, and whatever are called mediæval antiquities.

RAILWAY LIFT BRIDGE.

(With an Engraving, Plate XIII.)

J. U. RASTRICK, ESQ., ENGINEER.

This Bridge is in course of construction over the Surrey Canal, on the Brighton branch railway from New Cross to the river Thames; it is constructed of timber, consisting of four inverted trussed girders, which carry the rails, the ends of the girders bear upon sills supported by piling of whole timbers, 12 x 12 inches.

The platform is lifted bodily by six wire ropes, which pass over single grooved pulleys, supported by iron standards, and then descend and pass round doubly-grooved pulleys; the ends of the ropes are attached to six iron balance-weights, of two tons each. The lower pulleys are keyed on to iron shafts, which are turned by the wheel gear at the end, when it is desired to raise the Bridge.

The clear water-way is 21 feet, and the head-way, when the platform is lifted, 12 feet; the platform is 31 feet long by 23 feet wide.

GERMAN ARCHITECTURAL WORKS.

1. *Beiträge zur Kenntniss der Backstein-Architectur Italiens.* Von L. RUNGE. Berlin: Heymann. London: Franz Thimm.

2. *Die Bauwerke in der Lombardei.* Von FRIEDRICH OSTEN. Darmstadt: Leske. London: Franz Thimm.

3. *Kunstwerke und Gerüthschaften des Mittelalters und der Renaissance* Von E. BECKER und J. VON HEFNER. Frankfurt: Schmerber. London: Franz Thimm.

We may put these three publications together as affording materials for considerably enlarging the sphere of architectural study, and directing it towards edifices and works of art belonging to the mediæval period, which have hitherto been scarcely noticed, much less been illustrated, either by the pencil or by historical comment and description. This is especially the case with regard to the first work on the list, viz.: Runge's "Brick Architecture of Italy," though some of the examples are from Bologna, Ferrara, and other places usually visited by travellers, artists, and students. Yet, pre-occupied by the fame of the remains of classical architecture on the one hand, and by that of the modern standards of the art on the other, such visitors seem to have no eyes except for the Pantheon and St. Peter's, and for the buildings of Sansovino, Palladio, and other accredited masters. Surrendering themselves up entirely to their "Guide-book," they suffer their attention to be absorbed by, and their inquiry limited to, its directions. Next to seeing all that is there pointed out, it seems to be with them a merit to see nothing else—to search for nothing further. They do not even give themselves the chance of stumbling upon anything which their purblind and one-eyed "Guide" is unable to discern for them.

Even Woods himself is exceedingly unsatisfactory indeed in regard to some of the places and buildings he visited, for his visits seem to have been made *en courier*, and his notices of them—Ferrara and Faenza, for instance—are more provokingly tantalizing than complete silence would have been; or if they do not tantalize, it is because they mislead, by leaving it to be supposed that they really contain nothing at all worth an architect's attention. He does not even so much as hint at Brick Architecture in the North of Italy as constituting a peculiar style of ornamentation. Something, on the contrary, although in itself but very little, may be found in the 29th chapter of Hope's "Historical Essay of Architecture," in a note to which it is said: "In the plains of Lombardy, where stone is rare, clay has in buildings of importance, been moulded into forms so exquisite as to have been raised into a material of value and dignity. In the ancient churches of Pavia, &c., it presents itself in all the delicate tracery of the middle ages; in the Great Hospital,* Campo Santo, and Castiglione Palace, at Milan, it exhibits the arabesque, medallions, and scroll-work of the cinque-cento style. On this side the Alps, clay has never received forms quite so elaborate, &c. &c." This alone sufficiently recommends, or ought to recommend, Runge's work, which

* Most strange to say, Woods dismisses this extraordinary architectural monument as once, by merely assuring us that "it possesses little interest as an object of architecture"!—although it is an edifice of most singular character.

as far as we are aware, is the first publication that presents us with specimens of brickwork as it was formerly practised in Italy.

Did we previously doubt it, we should be convinced by these examples that brickwork, combined with moulded bricks and terra-cotta ornaments, is susceptible of a high degree of embellishment, and readily affords great diversity of combinations. But we are prejudiced against it by the slovenly coarseness of our modern bricks, which are only used for ordinary buildings, or else intended to be concealed by ashlar facing. Thanks to acts of parliament, which have prescribed their size and shape, ours are, as Hope observes, the coarsest and most unsightly bricks used in any country; yet why parliament should interfere with the fashion of bricks, more than with any other fashion, it puzzles us to make out. Such interference has certainly been so mischievous, that unless the interest now affected for the advancement of art be all make-believe and sham, such injurious restrictions ought at once to be repealed.

The frontispiece, or engraved title-page, of Runge's work exhibits the portal of the church of Sta. Caterina at Bologna, a composition of such remarkable elegance and delicacy, that it is astonishing it should have escaped the notice of those who professedly go in quest of architectural studies. The next plate gives us two admirably profiled cornices at Ferrara and Faenza, also the part of a window and highly enriched string-course from a house at the latter place; somewhat similar decoration to which, we are informed by the author, has been adopted in the restoration of the Klosterkirche at Berlin. A house at Bologna has furnished the subject of the two following plates, and although it cannot be affirmed that the building itself is by any means a model, the windows and some of the other details afford valuable hints. It is to be regretted, however, that the principal cornice and its frieze are not shown at large like some of the other parts, for if we may judge by what can be made out in the perspective view of the building, they are of particularly rich and elaborate design. The other plates show a variety of other cornices, wherein the mere arrangement of bricks of nearly the usual shape is made to produce very bold and effective mouldings for such purpose. Hardly need we add that Runge's work deserves to meet with extensive encouragement in this country, as one of real practical utility, and calculated to improve the character of brick buildings.

Osten's work, on the contrary, is more of an archæological and historical nature, in which respect it is a highly welcome contribution to the history of architecture in Lombardy and the North of Italy, from the 7th to the 14th century. It promises to go far towards filling up what is now an hiatus in the architect's library,—towards serving as a bridge across the chasm which separates the classic from the mediæval period of the art. Lombardic architecture has of late years obtained attention; yet, owing to the want of adequate notices and illustrations, those who have spoken of it have not been able to enter into the subject so fully as they otherwise might and would have done. We do not know whether Osten intends to give only unedited monuments, but even should any that have been before represented be here introduced, they will be more satisfactorily explained than hitherto. The principal monuments contained in the two first *Lieferungen* of the work are the cathedral of S. Evasio, at Casale, Monteferrato; the baptistery of S. Pietro, at Asti, and the church of S. Andrea, at Vercelli, of none of which is any mention at all made by either Seroux d'Agincourt, or Wiebeking, Hope, or Woods. Both the churches are interesting, that at Vercelli more especially, it being, we are told, the work of an *English* architect, named Briginthe—at least one whom the founder, Cardinal Guala Bicchieri, brought over from England, where that prelate had resided for several years. The edifice is further remarkable for having been completed within the short space of about two years, it being begun in 1219, and finished, together with the buildings of the adjoining convent, in 1222. It is accordingly uniform in idea, though it at the same time exhibits the combination of two different styles, for while the exterior is decidedly Lombardic, and the windows are very small semicircular-headed openings, the pillars, arches, and vaulting of the nave are expressly in the Pointed style, and some of the arches are unusually acute. The general dimensions of the plan are about 223 by 108 English feet, and 131 across the transept. The other church, viz.: that at Casale, which was begun in 741, by King Liutprond, and consecrated as a cathedral in 1107, by Pope Paschal II., forms externally a parallelogram of 170 feet by 104; but although the external form is so simple, the internal plan is very remarkable, the church itself, notwithstanding its moderate dimensions, being divided into five compartments or aisles, and preceded by an

atrium or Galilee; of which latter two sections are given, but not even one, unluckily, of the body of the church itself. The baptistery at Asti is a polygon of 24 sides—accordingly may be classed with rotundas. It is 53 feet in its external, and 46 in its internal, diameter, and 40 high to the summit in the centre of the plan; although to the edge of the sloping *lean-to* roof over the surrounding aisle, or whatever else it may be called, the height is only 17 feet. Strikingly piquant, the architectural character of the structure arises almost entirely out of plan, and its consecutive forms, independently of, and in this instance quite without, decoration; wherefore, were *naïve* a term current among architects, we should apply it to this building as a very appropriate epithet for it,—one that goes far towards expressing a prominent æsthetic quality in it. The edifice itself, indeed, belongs to a class now extinct; nevertheless, ideas available for other purposes than the original one, may be derived from it. Were our architects occasionally to turn to such studies as this example at Asti, and the Abbot's Barn at Glastonbury, they would not give us such fantastic monstrosities as they now frequently do when called upon to design buildings for industrial or economical purposes, for which a mediæval style is desiderated.

The third publication on our list, is of quite a different character from the other two, it being devoted to specimens of furniture and articles of *virtù*, both of the middle-age period, and that of the Cinque-cento and Renaissance. Most tastefully executed both as to drawing and colouring, it will form a very suitable companion work to H. Shaw's "Encyclopædia of Ornament," with which it agrees also in size,—at least the difference of size is so very slight, that the two books may stand beside each other on the same shelf. To many of our readers this, we presume, will be sufficient information as to the general nature and character of this collection of "Kunstwerke." Having as yet only the first *heft* or part before us, we cannot say which class of subjects will predominate, but the specimens themselves, selected from public and private collections at Vienna, Berlin, Dresden, Gotha, Cassel, Darmstadt, and other places in Germany, will be new to this country, and will extend our acquaintance with mediæval art and taste. That the latter reproaches the taste of our modern fashionable pseudo-mediævalism in furniture, is tolerably evident from an oak cabinet here represented, which unites extreme simplicity of general form with elaborate ornamental design. If we compare this with modern productions calling themselves designs for "Gothic furniture"—and we may mention those of Heideloff, both because he is a German artist of considerable repute, and because some of them have been not only shown, but extolled in the Art-Union,—the latter appear truly coarse and barbarous extravagancies, devoid of a single principle of either design or composition. To say the truth, some of Herr Heideloff's chairs are so preposterously absurd, that their clumsiness, inconvenience, and uncomfatableness, if not their ugliness, must deter any one from adopting them. Neither do we say that even such a specimen of furniture as the cabinet above-mentioned, is now suitable as an express model for us; for even the choicest and most genuine reliques of the kind require considerable modification, and ought to be regarded not as patterns, but as *studies*; and as a collection of such studies, these "Kunstwerke und Geräthschaften" promise to become a most valuable addition to the information we already possess—too scanty, perhaps, in itself—relative to "*industrial art*" during the middle ages.

OF LOGARITHMS.

By OLIVER BYRNE.

SIR—Having known for years the readiness with which you publish any thing interesting in art or science, even when it is not in strict accordance with the avowed objects of your excellent Journal, I take the liberty of sending you a few remarks on the construction of logarithms. Indeed, I know of no other periodical open to mathematical communications, particularly when the subjects require woodcuts to illustrate, or symbolical language to investigate.

Logarithms is as powerful an agent in calculation as steam is in mechanics; with this truth before us, it is strange that few know their proper use or how they are computed,—and fewer still, from the great labour attending the operations by any known method, attempt the calculation of these very important numbers. Since the days of Napier and Briggs, logarithmotechny, in a practical point of view, has received but little improvement, while logarithmic formulæ have been cultivated with great success, and advantageously employed to abridge many analytical inquiries in different parts of mathematics. However, it is also true, that some analysts have bestowed

much time and labour in search of a simple and direct mode of calculating logarithms, and though wholly unsuccessful, or very nearly so, as respects the ostensible object of the inquiry, they have been rewarded by the discovery of those interesting and momentous formulæ which constitute what is at present termed "the Theory of Logarithms." It is also worthy of remark, that Briggs, Halley, Sharp, Vlacq, and others, who brought the doctrine of logarithms to perfection, were not averse to arithmetical calculations; but our modern mathematicians depend by far too much on purely algebraical expressions, foreign translations, and mere hocus pocus operations on operational symbols.

In an inquiry on logarithms, it is usual to put N = any given number, a = the base of any system, and M = the modulus of the system. Substituting $1+n$ for N , &c., we have

$\log. (1+n) = M (n - \frac{1}{2}n^2 + \frac{1}{3}n^3 - \frac{1}{4}n^4 + \frac{1}{5}n^5 - \&c.,$ for the fundamental expression, from which several other formulæ are derived, hitherto used in the computation of logarithms. But the above series is only useful when n is a very small fraction; while the majority of those deduced from it, are only available in the process of determining logarithms from the combinations of others. The value of M , in the above series, cost Mr. Briggs 54 successive extractions of the square root, and 54 multiplications; and although many ingenious contrivances have been devised to abridge the labour of these extractions, the process is at best very tedious.

Lagrange converted the above series into

$$\log. m = rM \left\{ (m^{\frac{1}{r}} - 1) - \frac{(m^{\frac{1}{r}} - 1)^2}{2} + \frac{(m^{\frac{1}{r}} - 1)^3}{3} - \&c. \right\}$$

by substituting $m^{\frac{1}{r}}$ for $1+n$; r being entirely arbitrary. This formula can be rendered as convergent as we please, and therefore the value of r can be so assumed, that the logarithm of any number, m , can be determined to a limited extent, by using only the first term of the series, viz. from the equation—

$$\log. m = rM (m^{\frac{1}{r}} - 1).$$

This method, undoubtedly, is always applicable to the direct computation of a logarithm; yet it is the same in effect as that proposed by Briggs, and is equally laborious, on account of the great number of extractions generally required.

It is, perhaps, unnecessary to dwell at any great length on the difficulties attending the computation of logarithms by a direct process, independently of other logarithms; however, we cannot conclude these remarks without giving a remarkable expression, deduced by Professor Wallace, of Edinburgh. The form is this—

$$\log. x = \frac{b^{\frac{1}{x}}}{x^{\frac{1}{b}}} \cdot \frac{n(x^{\frac{1}{b}} - 1)}{m(b^{\frac{1}{x}} - 1)};$$

in which m and n are any numbers chosen at pleasure; x , always some value between 0 and 1; and b , the given base of the system. This expression leaves the base unrestricted, involves no infinite quantity, and is said by some to be "of great analytical elegance;"—yet, it is purely algebraical, and as to its practical utility in the actual determination of a logarithm, it is just as much use as any other intelligible hieroglyphics.

Perhaps you will allow me to state a fact, which you have tested*—i. e. that I have discovered a method by which the logarithm of any number, to almost any extent, may be calculated, independently of other logarithms, in a few minutes. Mathematicians and the curious will, I have no doubt, be obliged to you for publishing the following results. It is well known that when the diameter of a circle is *one*, the circumference is

$$3.14159265358979323846264338327950288419716939937511,$$

to 50 places of decimals. Now, I find the logarithm of this number to be

.49714987269413385435126828829089887365167832438044, which is true to 50 places. For the information of the general reader, it may be necessary to mention, that the logarithm of a number consisting of so many places of figures, has not been before computed to anything near this extent; for, by any of the known methods, such a calculation is almost impossible. From the above result, the logarithm of the area of a circle, when the diameter is *unity*, may be readily deduced, and is found to be

1.89508988136617146392379049884191282011529856145642; correct to the last figure.

* [We have witnessed Mr. Byrne's facility in calculating logarithms without the use of any book. It is highly desirable that his system of calculation should be revealed to the public.]—Ed. C. E. & A. Journal.

With equal facility, we obtain the logarithm of the contents of a sphere, when the diameter is *unity*, to be

$$1.71899862231049022184250149021129053768335957872764.$$

$$M = .4342944819032518276511289189166050822943970058036666.$$

July, 1847.

OLIVER BYRNE.

WARNER'S LONG RANGE.

For the following calculations of the dimensions of the balloons which would be required for the purposes of Mr. Warner's Long Range, we are indebted to the courtesy of Sir HOWARD DOUGLAS, whose scientific researches have so greatly tended to disabuse the public mind of errors respecting the resuscitation of an old project for aeronautic warfare.

It has been already explained that Mr. Warner's apparatus consists of a balloon, from which, when it has attained a proper altitude and position, heavy shot or shells are to be let fall, being detached from the car by self-acting mechanism: these missiles derive their destructive effects from the velocity acquired by the action of gravity during their descent, or from the disruptive force of an explosive composition contained in them.

First of all, let it be required to determine the greatest possible velocity which the shots will acquire.

Falling bodies are acted on by two vertical forces during their descent—the accelerating force of gravity, and the retarding force of the resistance of the air. The former of these forces is constant at all velocities; the latter increases very rapidly with the velocity, and may be assumed to vary as the square of it. Consequently, the resistance to the progress of the balls becomes greater and greater, till at last it just counterbalances the action of gravity: in this stage of the descent, the velocity is said to have acquired its "terminal value," beyond which further acceleration is impossible. When once, therefore, a falling body has acquired its terminal velocity, it is no longer accelerated, but continues its descent with precisely the same uniform velocity (unless new forces are brought into operation), till it reach the earth.

Now it appears from numerous experiments, that the terminal velocity of a 12 lb. shot, filled with lead, (that is, the greatest vertical velocity which the shot can acquire by descent) is 419.6 feet in a second: and to acquire such a velocity the ball must fall from a height of not less than 2749.2 feet. These results may be safely relied on, as they express the mean of a vast number of experiments. The terminal velocities of solid shot of various sizes differ considerably. As the solid contents of spheres vary as the cubes of their radii, and their surfaces only as the squares of their radii, it follows that the larger the shot the heavier will it be in proportion to the surface exposed to the air's resistance, and therefore the greater will be the terminal velocity. For shells filled with an explosive composition the terminal velocity is less than for solid shells of equal size, the former being lighter in proportion to the surface exposed to the resistance of the air.

If the resistance be taken to vary as the surface and the square of the velocity conjointly (the surface varying as the square, and the weight as the cube, of the radius), it may be easily shown that the terminal velocity varies as the root of the radius. Hence, $v = 178 \sqrt{d}$ is a general expression for the terminal velocity of a ball of d diameter, the constant 178 being determined by numerous experiments.

The doctrine of terminal velocities is beautifully illustrated in the descent of the parachute, which, after it has attained a certain velocity, will, if properly constructed, continue to descend uniformly, without any further acceleration. Another admirable illustration is afforded by falling rain, which, unless retarded by the air, would be so much accelerated as to destroy vegetation.

The idea of defence of fortified places by "vertical fire"—that is, by shot discharged so as to fall nearly vertically on the heads of the besiegers—was promulgated by the celebrated mathematician, M. Carnot, who, however, totally overlooked the resistance of the air, and supposed the shot to describe parabolas. In a Reply* to his theories, it was shown theoretically, that the retardation of shot descending vertically would render them all but inoperative; and the theory was confirmed by actual experiments, undertaken by the author for the especial purpose of testing its accuracy. The following extract details the nature and results of these experiments:—

* "Observations on the motives, errors, and tendency of M. Carnot's principles of defence, showing the defects of his new system of fortification, and of the alterations he has proposed with a view to improve the defence of existing places. By Colonel Sir Howard Douglas, Bart., K.S.C. C.B. F.R.S., Inspector-General of the Royal Military College. London: printed for T. Egerton, bookseller to the Ordnance, Military Library Whitehall. 1819."

"A cohœorn mortar was placed 100 yards from six new deal targets laid on the ground, and two new wadmill tilts spread out near them, to estimate by the impression made on them the force with which the balls would fall.

The first round was with the usual tin case, containing 33 four ounce-balls, with a charge of one ounce of powder, elevation 45°. The case went bodily about 130 yards without breaking.

Loose balls were then put in over a wooden bottom. After a number of rounds with the above charge and elevation, with different numbers of four-ounce balls, it was ascertained that the cohœorn would throw 42 of them 100 yards, and that the spread was, on an average, about 10 or 12 yards. It was not very easy to hit the targets and cloths, although they covered a surface of 774 square feet; but, in one instance, 22 balls left their mark. The indentation on the surface of the deal was so small that it could not well be measured—it certainly was not more than $\frac{1}{8}$ of an inch deep. A ball thrown with force from the hand appeared to make an equal impression. Those which struck the wadmill tilt did not penetrate, but merely indented the ground underneath. The penetration of the balls into the ground (which was of the softest nature of meadow) was, on an average, 2 inches; but the balls thrown by hand did not penetrate so far.

The mortar was then elevated to 75°, and with two ounces of powder and 42 balls made nearly the range as before; but the spread was increased to about 40 yards, so that it was difficult to hit the surface aimed at. Several balls did, however, at length fall on the targets and wadmill tilts. The impression on the former was something increased, but still so trifling as hardly to be measured; the balls did not go through the cloth, and the penetration on the meadow was only increased to about three inches."

Secondly, to determine the dimensions of the balloons necessary to raise the weights proposed by Mr. Warner.

By a well-known principle of pneumatics, the weight of the balloon and its appendages, when floating in the air in equilibrium, is equal to the weight of the air displaced. Now the density of hydrogen gas when prepared in large quantities for the purpose of inflation is about $\cdot 2$, or a cubic foot weighs $\cdot 2$ oz. In order to ascertain the density of the air, the diminution of barometric pressure due to the altitude must be taken into account; and if the balloon be supposed to have attained the average altitude of 2500 feet, the density of the air may be taken at $1\cdot 09$, or a cubic foot of air weighs $1\cdot 09$ oz.

Assume the balloon to be spherical, and call its radius r . Its solid content = $\frac{4}{3} \pi r^3 = 4\cdot 1887 \times r^3$.

The weight of that volume of gas = $\cdot 2 \times 4\cdot 1887 \times r^3$.

The weight of that volume of air = $1\cdot 09 \times 4\cdot 1887 \times r^3$.

The weight of 100 shells of 500 lb. each = 800,000 oz.

The weight of silk, netting, car, &c., taken for an approximate determination of the size of the balloon, = 73,931 oz.

Now, as has been stated, the total weight raised is the same as that of a volume of air equal to the capacity of the balloon, &c. Hence, neglecting the space occupied by the car and appendages, we have the equation $1\cdot 09 \times 4\cdot 1887 r^3 = \cdot 2 \times 4\cdot 1887 r^3 + 800,000 + 73,931$.

Whence may be obtained the following results:—

$$4\cdot 1887 r^3 = 981,945 \text{ (volume)}$$

$$r = \{61\cdot 602 \text{ (radius)}$$

$$4 \pi r^2 = 47,686 \text{ (surface)}$$

In other words, the capacity of the balloon and the quantity of gas which would be required to inflate it would be nearly one million cubic feet, the quantity of silk required in its construction would be forty-eight thousand square feet, and its diameter (double the radius) one hundred and twenty-three feet.

If instead of ascertaining the dimensions of the balloon at an altitude of 2500 feet, its dimensions necessary for raising the given weight just off the ground be calculated, the results will not be materially altered. In this case, the density of the air must be taken at $1\cdot 2$ (instead of $1\cdot 09$), and the diameter of the balloon will be found to be 119 feet instead of 123 feet. The following table shows the dimensions of the balloon necessary for sustaining the several specified loads, and the cost of the silk required in its construction.

Number and weight of shells or shot.	Required diameter of balloon in feet	Cubic feet of gas content.	Surface of balloon in square yards.	Quantity of material, yard wide.*	Cost of silk alone.
No. Weight.					
20 of 25 lb. }	33·0	18,816	380	570	300
50 of 10 lb. }					
40 of 25 lb. }	40·4	33,510	569	854	455
100 of 10 lb. }					
60 of 25 lb. ..	45·8	50,893	731	1097	584
80 of 25 lb. ..	50·1	65,440	876	1314	700
100 of 25 lb. ..	53·1	77,951	1010	1515	812
100 of 500 lb. ..	123	974,349	5298	7947	3,200

* The silk of which balloons are made is of the best quality, and only 24 inches wide so that a corresponding increase must be made.

WICKET-GATE FOR CANAL LOCKS.

Invented by F. C. LOWTHORP, Esq., C.E., of Pennsylvania, United States. (Reported in the Franklin Journal.)

The object of the apparatus is to draw water rapidly from a higher level to a lower; for example, to fill or empty lock chambers, or to draw off a canal level, mill race, or reservoir of any kind. It is effected by an ingenious application of hydrostatic pressure. In the effluent sluice is placed a gate, or wicket, with two leaves at right angles to each other, having a cross-section like the letter L, one leaf being longer than the other. This gate works upon pivots, or a hinge, at the angle of intersection of the two leaves, and at one side of the sluice. The shorter leaf of the gate is of proper dimensions to close the sluice when the flow of water is not required. This leaf is kept shut by the pressure of the head of water, which produces no effect upon the longer leaf so long as it is admitted freely to both sides of it.

When the sluice is to be opened, the water is drawn from one side of the longer leaf, and immediately the pressure upon the other side preponderates against the shorter leaf, and forces it open. The opposite effect is produced by admitting the water to both sides of the longer leaf, when the pressure upon the shorter leaf again closes the sluice. These alternate effects are produced by two small turning wickets at right angles to each other and coupled together, which are moved simultaneously by a single lever.

The time and effort required to manœuvre the small wickets will certainly not be greater than is necessary to work one of the simple turning wickets generally used in lock-gates, while the quantity of water discharged by the sluice will, with the above proportions, be about four-fold, and may, by a variation of the relative dimensions of the parts, be even greatly increased.

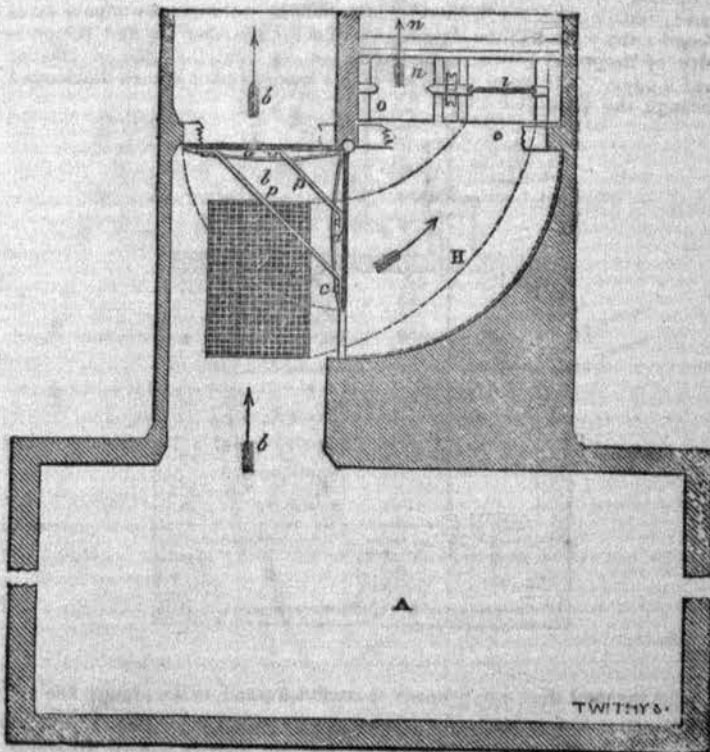


Fig. 1.

Fig. 1 is a plan, in which the part A is intended to represent a reservoir, lock-chamber, &c. a, d, shows the leaves of the wicket-gate (which is supposed to be placed in the side wall of a lock), both of which are secured to the shaft s, and are connected by means of the rods, or bars, p p. H is a recess or chamber, into which the leaf d moves in opening the leaf or gate a. i, o, are small valve gates (so connected or coupled, that both may be turned at the same time, the one opening, and the other shutting), used for emptying and filling the chamber H, and may be worked as shown in the plan and sectional views (figs. 1, 2, 3), or otherwise. c c is a channel or pipe, communicating with the water in the lock-chamber or reservoir A, and the chamber H, through the valve-gate i. g is a grating

intended to prevent the channel *c c* from becoming obstructed. *n n* is a channel or pipe, communicating with the chamber *H*, and the lower level, through the valve-gate *o*. *m* is a man-hole in the leaf *d*, for the purpose of getting at the small valve-gates *i, o*, for repairs and other purposes. *b b b*, shows the water-way communicating with the reservoir and the level below.

Fig. 2 is a longitudinal section of the plan, represented in fig. 1.

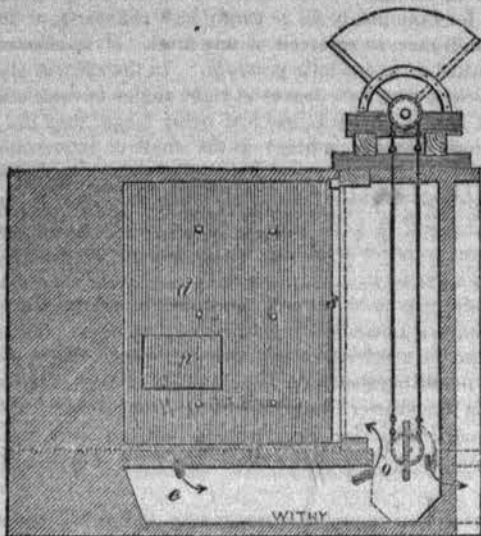


Fig. 2.

Fig. 3 is a cross section of the same.

The plan represents the wicket-gate as closed, and the lock, as well as the chamber *H*, full of water. When it is desired to empty the lock, the valve-gate *o*, communicating with the lower level, through the channel *n n*, is opened; at the same time, the valve-gate *i* (which is connected with the same), communicating with the lock-chamber, through the pipe *c c*, is closed; the water is thus discharged from the chamber *H*, and the pressure of the water acting on the larger leaf *d*, forces the gate or smaller leaf *a* open. The water contained in the lock-chamber is then discharged through the passage *b b b*.

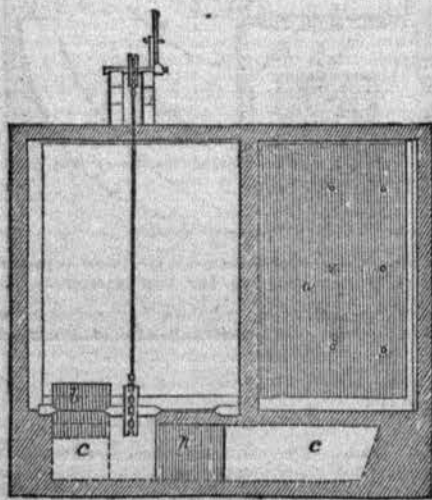


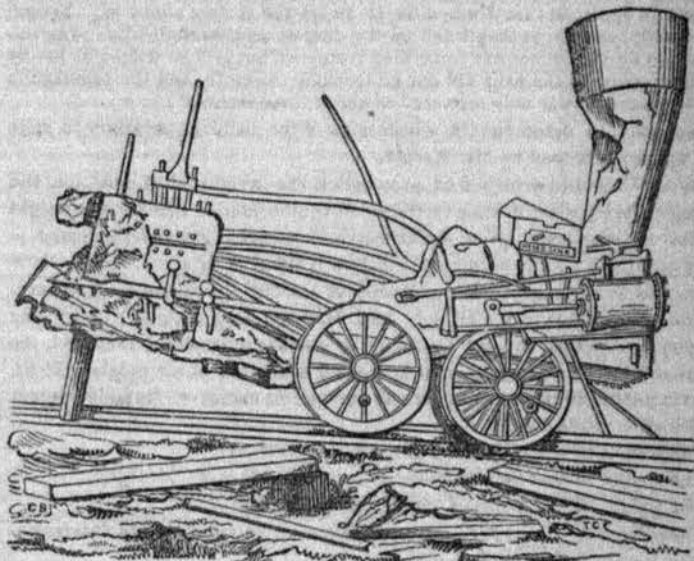
Fig. 3.

The inventor does not propose to confine himself to the precise mode of construction shown in the plan, but purposes availing himself of different modes of construction to suit different localities where gates for discharging water are used; the principle remaining the same, which consists in alternately applying and relieving the pressure from one side of the larger leaf (arm, or paddle) of a wicket-gate, thereby causing it to turn one way or the other, so as to force the other leaf of the gate open or shut, as may be desired; both leaves of the (valve-gate, or) wicket-gate being secured to, and made to turn on, or with, the same shaft, or axis; the shaft being placed in a vertical, horizontal, or in any other position desired.

EXPLOSION OF A LOCOMOTIVE ENGINE IN THE UNITED STATES.

The Committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred the examination into the causes of the explosion of the locomotive engine "Neversink," upon the Reading railroad, United States, on the evening of the 14th January last, report:—

That they have collected all the evidence bearing upon the subject which they could obtain, and have visited Reading for the purpose of examining the wreck of the engine; and they desire in this place to return their acknowledgments to the officers of the Reading Railroad Company, and especially to Mr. G. A. Nicolls, the superintendent, for their very great courtesy and kindness to the committee, in facilitating in every possible manner, their examinations, and putting them in possession of all information having a bearing upon the object of their research. The following is the result of their inquiries:—



The engine Neversink was originally built by Baldwin, and sent upon the road in April 1836. It then weighed 10½ tons, and had six wheels, two of which were drivers. The engine was thoroughly renewed and rebuilt by the Reading Railroad Company at their Reading depot, in April 1846, and was changed to an engine of 19 tons, on six wheels, all connected drivers.

In rebuilding it, four plates in length at the fire-box end of the cylindrical part of the boiler were retained, and 1½ sheets in length were added at the front end of the boiler. The new iron was five-sixteenths of an inch in thickness, the old one-fourth of an inch.

The vertical part of the boiler was 51 inches in diameter; the fire-box was 39 inches long, 37 inches wide, and 44 inches high; the crown was stayed with wrought iron bridge bars, and was so strong that it received no damage from the explosion. The horizontal portion of the boiler was 41½ inches in diameter, and 11 ft. 6 in. in length between the tube-sheets. The smoke-box was 2 ft. 3 in. inches in depth; making a total length of boiler of 18 feet. There were 128 wrought iron tubes, two inches in internal diameter and one-eighth of an inch thick in the wall; they had copper ends at the fire-box tube sheets.

There was but one safety-valve, 2½ inches in diameter, placed upon the dome; there were four gauge-cocks, the lower one of which was 8 inches above the crown-sheet, and the upper one about 14 inches above the lower. The highest tube was 1½ inches below the crown of the fire-box, and 11½ inches below the top of the cylindrical part of the boiler. The fire surface, reduced to fire-box surface, amounted to 309 square feet. The cylinders were 13½ inches by 20. The driving wheels 46 inches in diameter.

It was a favourite engine upon the road, and had run, previous to alteration, in April, 1846

71,010 miles.
Afterwards 18,041

Total 89,051 miles.

Upon their examination, the committee found the horizontal part of the boiler almost completely destroyed. In this part of the boiler

the explosion had manifestly originated, commencing in the older iron which remained in the hinder part of the boiler. The tubes were, for the most part, still fast in the tube-sheets, but they were bent outwards at their middle, like the staves of a barrel. The steam pipe, as it passed through the boiler, was *collapsed*, but not broken. The outer shell of the boiler had been torn into fragments, and the rents had extended to the vertical part, the upper portion of which had been entirely torn away, so as to expose the fire-box, which was sound, but slightly caved in on the sides. The cylinders were unharmed by the explosion, but had since been removed. The quality of the iron appeared to the committee to be uniformly good.

There was, therefore, nothing about the engine to indicate that the accident had occurred from defects in workmanship or material, nor, indeed, did the tremendous power which was indicated, seem consistent with the idea of an originally defective boiler.

The evaporative power of these heavy engines is necessarily very great. Mr. Nicolls assured the committee that the Neversink was capable of drawing a train of 88 cars, weighing, loaded, 7½ tons each, (equal to 637 tons,) at a speed of 12 miles per hour, (1056 feet per minute.) Allowing the traction to be 7½ pounds per ton, (as experiments upon this road show it to be,) this is equivalent to 153 horse power—requiring an evaporation of 2.55 cubic feet of water per minute.

Now, by the peculiar construction of these engines, rendered necessary by the restricted space allowable for the boiler, when the water-level stood two inches above the lower cock, the steam was confined exclusively to the hemispherical dome above the fire-box, the cubic content of which is rather less than 24 cubic feet, (23.8565 cubic feet.) The cubic content of each cylinder (13.5×20) is 1.657 (1½) cubic feet, and, as two cylinders are drawn at once, the ratio of the cylindrical content is as 3.314 to 24, or more than one-eighth. When the water-level is at the upper gauge-cock, the steam room is nine cubic feet, and the ratio about one-third. Now, the most recent (and apparently the best) authority upon the high pressure engine declares, after nearly 30 years of practical experience, that "the steam space should be at a minimum 20 times as great as the space to be filled with steam in the cylinder. If it can be made greater, consistently with the other arrangements of the boiler, so much the better." This is, of course, inapplicable in locomotive engines.

The reason, therefore, that these engines will throw water from the safety-valve, and from the gauge-cocks, when the actual water-level is dangerously low—and that, in the words of Mr. Kirk, they are ticklish in carrying their water, must be evident. The foaming in one of these engines must be incessant, and the danger of priming very great. The gauge-cocks, which, under the most favourable circumstances, are but indifferent indicators of the water-level, become, in this case, useless, and the engine driver must rely upon his experience of the engine and trust to incessant watchfulness alone, if he would avoid an accident.

A very remarkable fact about this explosion is, that the steam pipe passing through the upper part of the boiler, from the throttle valve to the cylinders, was *collapsed* and unbroken, as is well seen in the accompanying Daguerreotype portrait of the engine, taken after the explosion by Mr. David Monday, of Reading, and kindly lent by him to the committee. It is, indeed, possible that this may have been produced, during the explosion, by the sudden bending upwards of the tube, otherwise it would seem to indicate that the engine was throttled at the time of the explosion; an expedient which may have been resorted to for the purpose of avoiding the dampness of the steam, or to check the speed of the engine; but the fearful danger of which will be seen when it is considered that, if the steam was shut off but one-fourth, (the water being above the lower gauge-cock,) the pressure in the boiler would double itself in about one minute.

It seems useless to speculate upon the immediate cause of this terrible accident, since the death of all upon the engine has removed the direct testimony of the circumstances under which it occurred. However, it appears that the engine was under a very unusually heavy pressure of steam, and scarcely less certain that the safety valve was (accidentally or otherwise) fastened down. Mr. Nicolls and Mr. Kirk both testify to the competency of the engine driver, who was in charge, and every one bears witness to his character for sobriety. That he may have been deceived as to the height of water in the boiler is possible from the character of the engine, although it is difficult to imagine how an experienced hand could have neglected the indications given by the increased pressure, as shown by the rapid running of the train and the sharpness of the exhaust.

Upon the whole, it appears probable to the committee that the explosion of the Neversink occurred in this way:—

That the engine was running under a heavy pressure of steam, and that, owing to the defective indications of the gauge-cocks, the water

in the boilers was permitted to get below the upper tubes, which thus became unduly heated; that the rapidly increasing pressure (assisted, perhaps, by an injudicious partial closing of the throttle valve) caused the starting of one or more of the tubes from the forward tube-sheet, and this sudden relief of the pressure caused a foaming in the boiler, by which the water was thrown over the heated tubes, and being thus rapidly evaporated, caused an instantaneous increase of tension, which the additional openings were incompetent to relieve, and thus produced the rupture of the outer shell of the boiler. This, however, is intended only as a plausible suggestion, and by no means as a confident affirmation of the cause of the explosion.

But whatever hypothesis may be adopted to explain this unfortunate accident, its investigation has forcibly called the attention of the committee to several matters which they believe to be of sufficient practical importance to deserve the attention of the Institute.

First. The necessity of providing all steam engines with a second safety-valve, of large dimensions, regulated to the maximum pressure which the engine is intended to bear, and placed beyond the control of the engine-man. It is true that this will entail upon the owners the trouble of frequent examination to maintain the efficiency of such a valve, but this trouble will be more than compensated by the increased safety which will be procured by its use.

Secondly. The uncertainty of the ordinary gauge-cocks, as indicators of the water-level under the most favourable circumstances, and the deceptive character of their indications upon the modern locomotive engines, where the amount of work to be done and the restricted space which can be allowed to the boiler, necessarily confines the water and steam room, and renders the evaporation more tumultuous than in the larger boilers of stationary engines.

Thirdly. The committee would suggest the inquiry whether it is not feasible and advisable so to construct the locomotive engine that explosions, if they occur at all, shall take place in such a manner as to be less destructive to human life than they at present are. One of the great recommendations of the tubular boiler, when first introduced into use, was this very diminished liability to do injury, by allowing a tubular flue, of comparatively small size, to collapse, in place of the large cylinders, by which the boiler was at once emptied of its contents.

REVIEWS.

Earthwork Tables. By CHARLES K. SIBLEY, C.E., and WILLIAM RUTHERFORD, F.R.A.S. London: Longman and Co., 1847.

These tables are for the purpose of estimating the contents in cubic yards of the earthwork of railways: they are calculated, by the ordinary prismatic formula, for a central width of 33 feet at slopes of 1, 1½, and 2, to 1; heights from 0 to 60 feet, at intervals of half-a-foot.

The advantages of the tables are, that there is no necessity for a second calculation, as at one glance the cubic contents of a chain in length are seen by merely looking for the corresponding heights of the respective ends of each chain's length in the table,—the heights of one end being given at the bottom of the table, and the other height on the side, and at the intersection of the two lines the cubic contents are given. Thus, for a cutting 5 chains in length, of the respective heights of

{ 0, 7½, 13, 11½, 3½, and 0, the contents are read off { 348, 1090, 1355, 756, 151:—total, 3700 cubic yards.

We believe these tables are the only ones that offer such a facility of calculation; consequently, we strongly recommend them to the Profession.

We must observe that there is another table, by which the contents for any other width, from 23 to 43 feet, may be found; for this purpose, it will be requisite to have two inspections, but no multiplication.

Architectural Maxims and Theorems, and Lecture on the Education and Character of the Architect. By THOMAS LEVERTON DONALDSON, M.I.R.A. London: John Weale, 1847.

Professor Donaldson has laid the ground-work for an excellent book; but in the present edition the Maxims are too concise, and are not carried out sufficiently to render them of much service to the student. Many of the Maxims require an explanation and a reasoning to prove that what is set forth is true. We feel assured that Mr. Donaldson, if he can devote the time to the work, will be enabled to enlarge it in such a manner as to make it a valuable work of

reference, not only to the student, but also to the experienced architect.

With regard to the Lecture which is appended to the present work, we can only say, at the present time, that it is a good summary to a course of lectures, but there are some portions of it with which we cannot agree;—our reasons for differing must be deferred to another opportunity.

The Art of Sketching from Nature in Perspective Simplified by the Goniometricon. By GEORGE EARL, Principal of the School of Design, Peckham. London: G. W. Medes, 1847.

We gave a short account of this instrument in the Journal for December last (Vol. IX. p. 369). The object of the present work is to show how the instrument may be used; it is extremely simple, and is handled with great facility. It will be found of great service to the travelling student in taking sketches of buildings and other objects.

The Tradesman's Book of Ornamental Designs.—The second part of this work fully sustains its character for utility: the design for an iron gate is exceedingly good.

REGISTER OF NEW PATENTS.

RAILWAY AXLES AND SIGNALS.

THOMAS WATERHOUSE, of Edgeley, near Stockport, cotton manufacturer, for "mechanical Improvements applicable to railway engines and tenders, and to railway carriages of various kinds."—Granted March 10; Enrolled Sept. 10, 1847.

The object of the improvements is, firstly, to facilitate the passage of railway engines and carriages round curves, by allowing each wheel to move independently of its fellow. This is effected by forming one of each pair of wheels with a long nave equal to one-half the diameter of the wheel to which it is applied, which is bored to fit the axle, and to work against a shoulder on the same; it is to be kept in contact with the shoulder by a washer, secured to the axle, outside the nave by a key; the other wheel is fixed to the opposite end of the axle. Another method is to divide the axle at the centre into two parts, and fix bearings to the lower framing of the carriage, for the purpose of supporting the inner ends of the two parts of the axle; by which means the wheels are permitted to rotate independent of each other.

The second improvement is for an apparatus for sounding signals by means of compressed air; consisting of a force-pump for compressing air into a receiver beneath the carriage, from which it can be admitted, by the guard or attendant, into a railway whistle or other instrument for sounding signals.

DRESSING LACE AND FABRICS.

JOHN KEELY, Jun., of Nottingham, dyer and lace-dresser, for "Improvements in dressing or finishing lace and other fabrics."—Granted December 14, 1846; Enrolled June 14, 1847.

This invention relates to a dressing for lace and other fabrics, which when made up, will not be liable to absorb moisture from the atmosphere, but will preserve their shape when exposed to heat or damp. 5 lb. of shellac is to be dissolved with 1 lb. of borax in 3 gallons of hot water, or the shellac may be dissolved by other alkalies, and in different proportions to the before-mentioned. The solution of shellac may be used alone, or, when thought desirable to give a greater degree of stiffness, it may be mixed with starch, gelatine, glue, or other stiffening material, dissolved by the ordinary methods, and then stirred into the solution of shellac while the latter is at a boiling heat: the quantity of stiffening material added will vary according to the stiffness required; the addition of 1 lb. of glue to a solution containing 1 lb. of shellac has been found to answer well. The solution is applied by dipping the fabric therein, or spreading it upon the fabric; the finishing is proceeded with in the ordinary manner.

GAS METERS.

THOMAS EDGE, of Great Peter-street, Westminster, for "Improvements in the manufacture of gas-meters."—Granted Dec. 31, 1846; Enrolled June 30, 1847.

This invention relates, firstly, to the manufacturing of gas-meters of plates or sheets of iron, covered with a coating, first of tin, and

then a coating of zinc, or with an alloy consisting of tin and other metals, to prevent or retard the destructive effects of the gas. The metals or alloys employed for this purpose are tin and zinc, as being found in practice to be the most desirable and efficient. Any known method for coating plate-iron with these or other metals may be employed. The inventor lays no claim generally to the coating or covering of plates or sheets of iron with zinc and tin, or with any alloy of metals, as these processes form no part of his invention when taken separately.

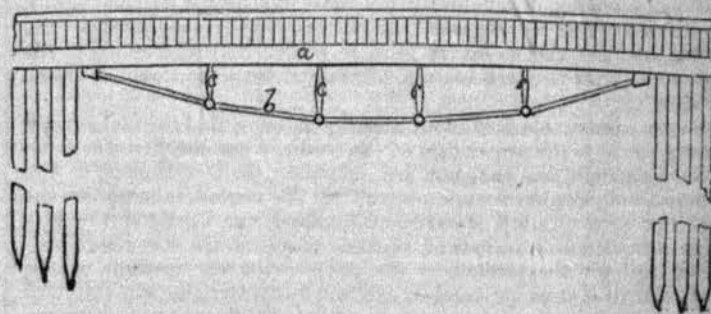
The second part of the invention is for forming the internal parts of the meter of the same or a similar kind of metal, so that no voltaic action may be induced between the several parts, by constructing them of an alloy of metals, as being most suitable, and which alloy is made to bear some analogy to the particular coating of the plates or sheets of iron of which the case is constructed; and, in order to preserve the solid parts, which are liable to be injuriously acted upon by the gas, or that come into contact with the water that becomes impregnated with the gas that passes through the meter, the inventor constructs them of an alloy of metals, consisting principally of zinc and tin, the proportions of which may be varied, or other metals may be added, for the purpose of hardening the alloy. For the above purposes, an alloy consisting of from 50 to 70 parts of zinc to from 30 to 50 parts of tin, will be found to answer the object required.

PIERS AND HARBOURS.

PETER BORRIE, of the Crescent, Minories, City, engineer, for "Improvements in the construction of piers and harbours."—Granted Dec. 21, 1846; Enrolled June 21, 1847. (Reported in the *Patent Journal*.)

This invention relates, first, to the construction of piers, whereby the communication is maintained between the approach and the vessel, without the intervention of stairs, at all times of the tide. It consists of a combination of a permanent way, a floating pier, and a platform connecting the two, which is hinged at one end to the permanent way, and at the other rests on the barge or vessel, which rises and falls with the tide. For light traffic this erection is constructed almost entirely of wood; the permanent way, which in the drawing is represented as being curved, but which may be formed according to the nature of the approach, is supported on piles driven into the ground; the space between each set of piles leaving a clear water-

Fig. 1.



way. The roadway, which is of peculiar construction, is represented at fig. 1. Beams, *a*, are laid longitudinally and resting on the piles; at their extremities they are slightly curved upwards and strengthened by means of tension-bars, or chains, *b*; these chains are secured to a cast iron cap on each end of the beam, and support it at intermediate points by stretchers, *c*, *c*, *c*. Now, it will be obvious that the tendency of weight placed on the centre of the arch will be to straighten and, consequently, lengthen the beam, thereby throwing the greater part of the strain on the chain *b*. The barge, or floating part of the pier, is placed between two buttresses formed of piles, one at either end, and by them is guided in its rise or fall with the tide; and it is generally preferable to place this barge parallel to the current, without regard to the position in which it is necessary to connect the roadway; this barge may be constructed of iron, with a wooden deck, or it may be wholly of wood; the inner side, on which the hinged platform rests, having a greater displacement of water to compensate for the weight thereof, and it is furnished with water-tight bulkheads for additional security and strength. The platform which connects the roadway with the floating barge, is constructed in a similar manner to the permanent roadway, being formed of longitudinal beams, strengthened by tension-rods and stretchers, as before described; one end of these beams is connected by a strong bolt, passing

through the cast iron caps and corresponding knuckles, fixed to the piles which support the extreme end of the permanent way, and thus forming a hinge on which it rises and falls; these piles are strengthened sideways by means of struts, so as to enable the structure to resist the strain consequent thereon; the other end of the platform, which rests on the barge, is furnished with rollers, which traverse rails placed in a recess formed in the side thereof, so as to bring the surface of the platform on a level with the deck. The flooring of this structure is supported from the beams by joists which, with other transverse fastenings, connect the whole firmly together, and it is surmounted by a railing as in other similar erections. Piers intended for heavier traffic, he constructs in a manner very similar to the foregoing, but with the several parts of a proportionate strength; but in many cases, where the rise and fall of the tide is too great to admit of the whole of the inclination being thrown on one moveable platform, he, therefore, makes use of an intermediate floating barge, protected by buttresses; this arrangement avoids the necessity of having the platform of any extraordinary length, when any great height is to be attained. Instead, also, of the rollers at the end of the platform bearing directly on the floating barge, it rests on a frame which is supported by a strong shaft laid horizontally in the direction of its length; this admits of a rocking motion, and, consequently, prevents any strain from twisting or affecting the permanent pier, to which the other end is affixed. In piers constructed for every description of heavy goods, in place of supporting it on piles, it is erected on a base of solid masonry, supporting cast iron pillars, on the top of which the longitudinal beams are placed, and the whole is finished in a manner proportionably strong for the accommodation of wagons and other vehicles; the platform of this pier also rests on an apparatus, the same as before described, for the purpose of counteracting the rolling of the barge from the action of the waves.

The floating-barge of this pier, supposing it to be erected where it will be subjected to the action of the sea, is constructed with open-ended tubes passing through from side to side, as also from the deck to the bottom; this not only materially strengthens the barge, but allows the sea to break through and thereby partially avoids its effect. Having described the nature of his invention as regards piers, he states that he is aware they have before been erected where the communication has been effected by means of a platform, rising and falling with the tide, but what he claims is the peculiar construction of low-water piers, adapted for all kinds of traffic, and for the accommodation of all classes of vessels in loading or delivering passengers or goods of all kinds, at any state of the tide, without the intervention of stairs between the fixed and floating piers, and which pier forms

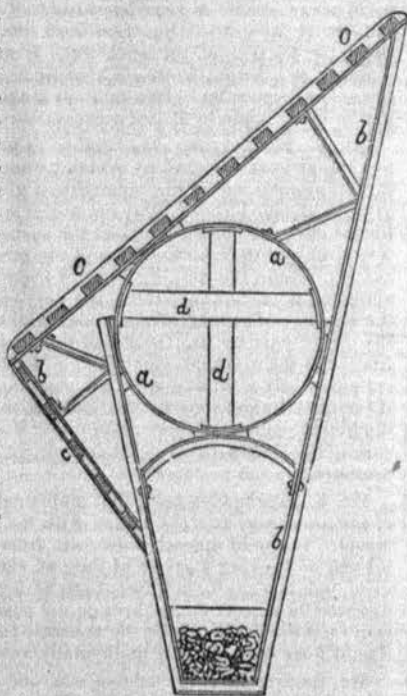


Fig. 2.

proper roadways for carriages, carts, wagons, or other vehicles, even of the heaviest description, coming to or going from such vessels lying alongside the floating-piers; and when such piers are to be adapted for ferries, the floating-piers may be made of such a height that their decks will be level with the deck of the steamer or other vessel used for the ferry, so that any carriage or vehicle may drive down the pier, and on board such steamer or vessel, without disengaging the horses, and which piers are constructed in the peculiar manner herein shown. The second part of this invention relates to the construction of a floating breakwater, for the protection of shipping in harbours, bays, estuaries, or other inlets of the sea. Fig. 2, represents a transverse vertical section of this breakwater, and fig. 3, an elevation of the same; it consists of a cylindrical caisson *a*, of iron, which being rendered water-tight forms the buoyant part on which the whole structure is supported; *b, b, b*, is a frame-work made of iron, attached to the caisson; on this frame-work a number of planks, *c, c, c*, are fixed longitudinally, which as the sea breaks through renders it comparatively smooth on the inside. The caisson *a*, has a

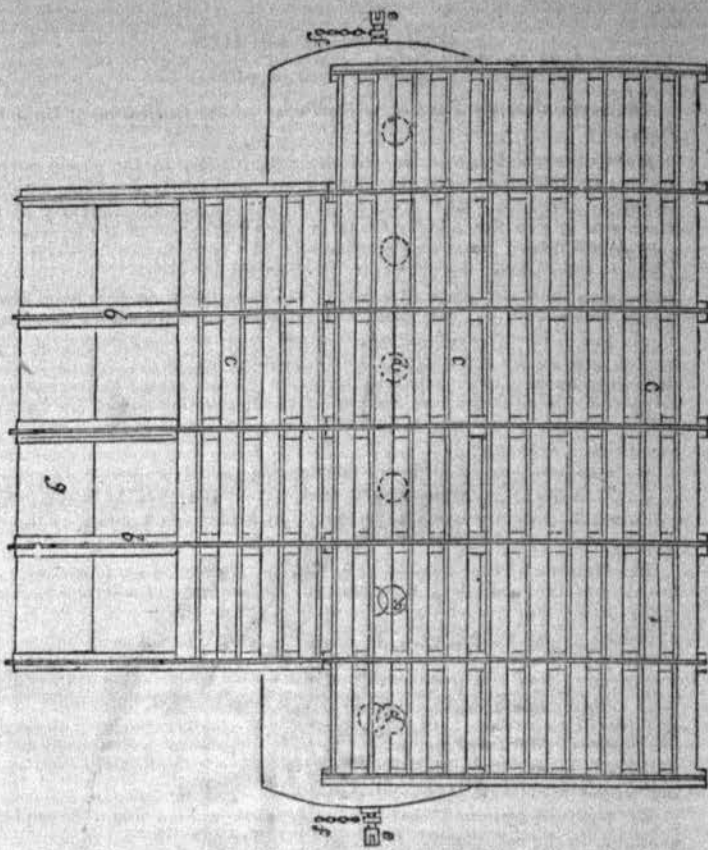
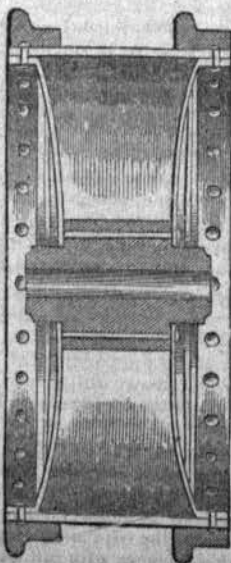


Fig. 3.

number of tubes, *d, d*, through it, both vertically and horizontally; these tubes allow the sea to break through, and consequently lessen the effect thereon, and likewise tend considerably to strengthen it; at the lower part of the frame-work a ballast-chamber is placed, which has the requisite quantity dropped through vertical tubes, *d, d*; several of these breakwaters may be connected together by the joints *e, e*, according to the entry of the harbour; the whole is secured by the chains *f, f*, to a suitable anchorage in the position most desirable for obtaining the desired effect. He does not claim the invention of floating breakwaters of iron, or other material; but what he claims is the forming of floating breakwaters in the peculiar manner represented in the drawing, and as hereinbefore described.

RAILWAY WHEELS AND BREAKS.

HENRY GRAFTON, of Holborn-hill, engineer, for "Improvements in railway wheels and apparatus connected with railway carriages."—Granted January 16; Enrolled July 16, 1847.



The improvements relate, firstly, to the formation of wheels for railway carriages, to adapt them for running on different gauges. The annexed engraving shows the construction of the wheel with two flanges or railway tyres. In place of spokes, the inventor proposes to have two dished plates formed of corrugated iron, which are made by pressing the plate in a mould; the centre to be rivetted to the nave and the outer rim to the tyre and a cylinder of sufficient width to receive the two tyres—the distance regulated according to the different gauges.

The second improvement is for a railway-break, consisting of a metal band placed between the two tyres, which by a lever is made to press upon the periphery of the wheel between the two flanges.

BARLOW ON ARCHES.

(Continued from page 215.)

(Remarks after the Reading of the Paper at the Institution of Civil Engineers:)

Mr. CURTIS, V.P., said he felt the propositions in the paper were so conclusive, that they scarcely afforded an opportunity for remark, much less for discussion. The great merit of the communication, and of the illustrations, was the adaptation to practice; in most of the treatises on arches, the theory alone was considered; Mr. Barlow had, however, very properly pointed out the possibility of constructing arches of certain forms and dimensions, strictly within the theoretical rules, so that they should stand well alone; but that when any pressure was imposed on them, they would fail. These were points of great importance, which should never be lost sight of by the engineer, and demanded not only great attention to the proportions of the structure, but also to the quality of the materials employed, the situation, the nature of the foundation and of the backing and numerous other considerations, in order to adapt the arch to the use for which it was intended.

Mr. SOWTHY agreed in the value of the paper. He viewed it more particularly in its application to the construction of arches in mines, where solidity and permanence were of such importance, on account of the unequal pressure to which they were subjected.

Mr. BRUNEL had endeavoured, during the reading of the paper, and the remarks of the preceding speakers, to find some point whereon to found observations, but it was very difficult, as the author's practical experience appeared to have constantly directed his theoretical investigations. He thought, however, that the compressibility and elasticity of materials of construction had not been sufficiently insisted upon. This did not generally obtain enough consideration, yet it was of great importance to the stability of a structure; all materials, even to granite, possessed an amount of elasticity, and it did not suffice to have the line of pressure fall merely within the mass; it should be sufficiently within it to allow for any yielding from elasticity, without endangering the building.

Mr. PELLATT observed, that the valuable information might be rendered available in the construction of the vaults of furnaces, the duration of which was of great importance in the glass manufactory. It was desirable that the crown of the arch of a glass furnace should be so low as to keep the heat well down, and yet if it was too flat, it was soon destroyed by the impinging action of the flame, or else the expansion of the materials by the heat destroyed the equilibrium of the arch, and it fell. At present the practical judgment of the workman was alone depended upon for the proper form, and the consequence was, that although a well-built furnace arch might last 14 years, it might not last longer than 14 months.

Mr. INMAN said that the ruins of ancient buildings would afford many striking lessons of the correctness of the principles laid down in the paper. Numerous examples of remains of arches standing without other support than the stones of which they were composed, might, he believed, be found, which could corroborate the views of the author, and he recommended such examples being sought for as illustrations.

Mr. R. STEPHENSON wished to express his conviction of the useful character of the paper, which, he was convinced, would remove many difficulties hitherto felt in examining the subject by the process laid down by Professor Moseley, whose formulæ, though highly scientific, and no doubt very beautiful, were much too abstruse for the use of the practical man. Any thing which tended to elucidate these formulæ, and render the subject more popular, must be received with great interest by the civil engineer, whose labours would be materially facilitated by such clear adaptations of theory to practice. It would appear, that the principal novelty consisted, in describing by a simple process from two given, or assumed, points, a curve of equal horizontal thrust, falling within such points in the voussoirs, as should demonstrate the stability or instability of the structure. There could be no doubt of the value of such a process; but he would suggest to Mr. Barlow the desirableness of giving, in somewhat more precise and simple terms, the mathematical demonstration of that which must be universally admitted in practice. He would suggest whether Moseley's term of the "line of pressure," as contra-distinguished to the "line of resistance," did not convey the meaning of the proposition better than the term "curve of horizontal thrust." It was accepted as perfectly true, that, as stated in the paper, the horizontal force at any part of the curve was opposed by a horizontal force of equal amount, exerted in an opposite direction, and that the horizontal force or thrust was equal throughout the curve, and hence the equilibrated arch; yet this had not been hitherto clearly and simply laid down, in such a manner as to be practically used.

Mr. BIDDER accorded with Mr. Stephenson in his appreciation of the value of the paper, he had seldom heard one of greater utility, and he trusted so good an example would be followed in the Institution. The proposed mode of describing the curve or line of pressure, showed the impropriety of constructing brick arches in separate superposed rings; the line would in almost every instance, travel out of the ring in which it commenced, and in case of fracture, the rings would fail consecutively; but if the arch was well bonded together throughout its entire depth, the line, or curve, would be traced within it, and it would possess the requisite strength. All the best brick arches were now built in that manner with full bond.

An arch had recently been so built by Messrs. Grissell and Peto over the River Lea, with a span of 87 feet, and a rise of 6 feet; the centres were struck within an unusually short time after the arch was keyed; but it stood perfectly, and with very little subsidence. He was tempted to consider an arch constructed of rectangular bricks set in a matrix of cement, as a bent trussed girder, the tension rods of which were represented by the abutments of the arch. Very flat arches, such as the Maidenhead Bridge, were examples of what he meant.

Mr. BRUNEL could not agree with Mr. Bidder's comparison, or what he might be permitted to term his amusing theory; on the contrary, he must contend that there was no analogy between the arch and a trussed girder. In the former the main force was pressure, in the latter the force exerted was tension; the abutments of the one had to resist a horizontal thrust, at a given angle, whilst the wing walls, under the other, had to support only a vertical pressure; any tendency towards horizontal thrust, which might have arisen from deflection of the beam or girder, was prevented by the tension rods which connected the opposite extremities. If an arch could be considered as a bent trussed girder, it must follow, that it would stand equally well whether the curve was upwards or downwards, which certainly did not accord with his notions of the properties of an arch.

Mr. BIDDER replied that his views were misapprehended; what he contended was, that a brick arch being formed of rectangular pieces, set in a matrix of cement, having great adhesive properties, upon which it in a great measure depended, it should be considered as a homogeneous mass, assuming the nature of a curved trussed girder, the resistance of the abutments acting as the tension rods of a girder. He must still contend for his position, and that the bridges of great span and small rise, erected by Mr. Brunel, were excellent examples of the construction he meant.

Mr. R. STEPHENSON considered that Mr. Bidder only meant to put forward the position for the sake of argument. It was certain, that the arch and the trussed girder, being supposed to be formed of the same materials, the former would be supported by the resistance of the abutments to compression, and the latter by the tension of the tie-rods; the adhesive properties of the materials not being in either case taken into consideration. The arch, *per se*, should always be considered as composed of separate masses, not set in a matrix; but combined in a certain form, the only adhesion being the friction of the surfaces. It would be desirable if Mr. Barlow would give a more perfect mathematical formula for describing the curve; the rule which he had given had too much the character of being empirical and of being made to fit given cases.

Mr. W. H. BARLOW was unable to perceive any deficiency in his definition, or in the method by which he ascertained the curve. The line of thrust, as obtained by the construction given in the paper, was practically given in the models.—It was not a necessary condition of stability, that the line of pressure should intersect the surfaces of contact at right angles, it was sufficient that the direction of the pressure should meet the surfaces of contact, within the limiting angle of friction. The same condition was exemplified in a column; there the line of pressure was a vertical line, but the surfaces of contact of the stones might be inclined, without occasioning the upper part to slip, provided the inclination was within the angle of friction of the material employed.—Moseley's formulæ, although theoretically perfectly accurate, were too complicated, and involved too much mathematical knowledge for the general use of practical men.—A deep or thick arch contained more than one "line of pressure;" the line of pressure to be dealt with in practice was, in effect, the centre of a surface of pressure.

Mr. R. STEPHENSON said, that mathematicians always considered the line of pressure to be at right angles with the supporting surfaces or the abutments. It would appear, however, from Mr. Barlow's explanation, that instead of drawing a series of lines at right angles to the surfaces through given points, thus forming what might be termed the polygonal theory, he described a correct curve through the same given points. Mr. Stephenson could not understand how the voussoir could give a line differing from the line of force treated of by mathematicians.

Mr. BRUNEL said, the subject was one of great difficulty, as it embraced so many considerations; it might, however, he thought, be rendered simple, by considering an arch not as composed of separate voussoirs bound together by cement, thus involving other principles, but as a homogeneous, and, he might almost say, an elastic mass. If viewed in that light, the pressure would be found to extend more or less over the whole surface. The "centre line," or "neutral axis," might in such case receive the denomination of the "line of pressure." If this idea were followed up, there would be less difficulty in explaining the principles laid down by Mr. Barlow.

Mr. W. H. BARLOW said, that Mr. Brunel's "line of neutral axis" expressed more nearly what he understood by the "line of pressure," and that line described by the impinging points of the curved surface of the voussoirs of the model. Mr. Barlow thought, that Mr. Bidder's experience, as to arches turned in one entire bond, being stronger than those composed of separate rings, bore out the deductions of the paper. The rings could not separately contain the curve of equal horizontal thrust; but when bonded they did so. An arch turned in separate rings depended too much on the adhesive strength of the cement or mortar.

Mr. CURTIS, V.P., said, it appeared to him that the whole question was contained in the proposition demonstrated by the model with curved

voussoirs, where the points of contact, and consequently the curve of pressure, varied according to the spot where the pressure was imposed. In practice, this pointed out the necessity of adapting the form of the arch to the service it was intended to perform. For instance, if the roadway over an arch were level, and the pressure equal, the fracture would take place by depression of the haunches and the opening of the extrados of the crown; but if the roadway were curved, the pressure being thrown upon the crown, the crown would fall, and openings would occur at the extrados of the haunches. Different calculations must therefore be made for the different constructions.

Mr. G. SNELL observed, that Mr. Barlow, in his geometric construction of the line of resistance, assumed, that there were already two points found. Now two points in the line of resistance were determined, when the points of rupture were known; for, at the time when rupture was about to take place, when the arch was balancing between standing and falling, the line of resistance touched the extrados or intrados of the arch, at the points of rupture. One of these points of rupture was determined by the conditions of the question, the other might be determined by a geometric construction, founded on the principles set forth in Moseley's works, and which he had demonstrated in his lectures. The process was one of approximation, and he supposed three trials would be sufficient to determine the point of rupture, with perfect accuracy. The process would apply to all shapes of arches under pressure, in any direction, in any position, or of any amount; but Mr. Snell would at present confine himself to the simple case of an arch which was loaded equally on either side, and the voussoirs of which were equal each to each, on either side of the centre line. In such a case, the one point of rupture would be at the crown of the arch, which would be on the point of turning on one of its edges, at its extrados, if the arch was about to fail by the sinking of the crown; and at its intrados, if it was about to fail by the rising of the crown. In the first case, some stone at the haunches would be on the point of turning on its edge at the intrados. In the second case, some stone at the haunches would be on the point of turning on its edge at the extrados. He would confine himself to the first of these cases. Then, to find the point of rupture, choose some point C (fig. 1), which was considered to be near the point of rupture, and which, in this case was at the intrados; draw C D the joint of the voussoir. The arch being about to fail, by the turning of the key-stone on its edge at A, the resultant of all the forces, at that point, must touch the curve of the

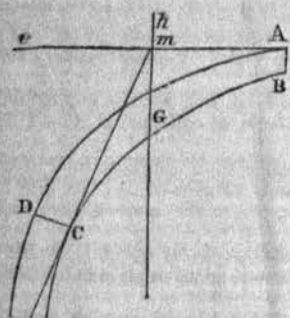


Fig. 1.

extrados at A; its direction was therefore horizontal, and was represented in position and direction by the line A e. The resultant of the weight of the mass A, B, C, D, was represented in position and direction, by a vertical line passing through the centre of gravity, G, such as G h. Now, the only forces acting on the point C (in this case) were the resultant of the forces at A, and the weight of the mass A, B, C, D, and these, being represented in position and direction respectively, by A e and G h, which intersected at the point m, the resultant of all the forces acted through m; it also acted at C, and therefore m C represented the resultant of all the forces acting at C. Now, as before stated, if C was the point of rupture, the line of resistance touched the curve of the intrados at C, therefore a tangent to the line of resistance at C was also a tangent to the intrados, and the resultant of all the forces, acting on any point in the line of resistance, was in the direction of a tangent to that line. Therefore, if C was the point of rupture, m C was a tangent to the line of resistance, and therefore m C was a tangent to the intrados, as in fig. 1. If C was not the point of rupture, but if the point of rupture was above C, m C would cut the intrados, as in fig. 2; but if the point of rupture was below C, m C would cut the intrados, as in fig. 3.

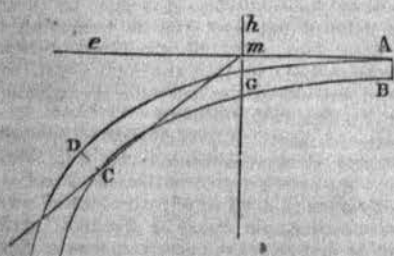


Fig. 2.

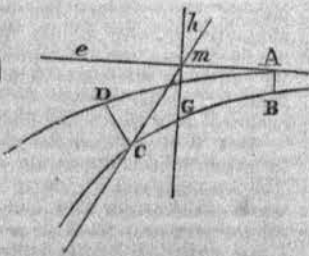


Fig. 3

Mr. H. W. BARLOW said, he assumed two points in order to facilitate the investigation. As far as practical utility was concerned, the line of thrust might thus be obtained at one operation, instead of pursuing the laborious process necessary for determining the theoretic line of resistance; indeed, excepting for the most regular geometric forms of the arch, Moseley

also adopted a tentative process. Moseley's line of resistance touched the intrados and extrados at the points of rupture. Now a practical eye could detect very closely which would be the point of rupture, and a curve of equal horizontal thrust drawn through these points, though it might not produce the line of resistance with mathematical accuracy, was sufficiently near it for all useful purposes. Moseley's theory was undoubtedly very perfect; in fact he was the only mathematician who had treated the subject consistently with its practical requirements. The difficulty in his mode of investigation was in those arches which did not partake of regular geometric forms, and in these cases Mr. Barlow's method would be found easy of application.

Mr. BRUNEL still thought, that Mr. Barlow had scarcely met the objections which had been raised. It was true that in practice some points might be assumed; but it was more satisfactory to have positive rules for finding these points, and assuring the mind as to the correctness of the basis of the proposition. In a very large arch, with a small rise, the line of pressure must be confined within very narrow limits, and in such a case a formula giving the points definitively was essential for inspiring confidence.

Mr. W. H. BARLOW replied, that the limits which confined the line of resistance, depended on the thickness of the arch and not on the ratio of the rise to the span; the points of rupture in ordinary forms of arches were well known; they were at the extrados in the crown, and at the intrados in the haunches; there was, therefore, no difficulty in finding the line of resistance in these cases. If the mind was as perfectly impressed with the direction of the forces in arches, as in the case of columns, both could be built with equal security.

Mr. G. SNELL stated, that in all cases of equal thickness of voussoirs throughout, Mr. Barlow's rules might apply; but if the thickness was less at the crown, as in the case of an arch with a keystone of limited depth, but of which the voussoirs increased towards the abutments until they came to an extreme length, he did not see where Mr. Barlow could assume his points in the line of resistance.

Mr. W. H. BARLOW replied, that in reference to that particular form of arch, it was evident many curves of equal horizontal thrust would be drawn within the thickness, so that it was unnecessary to entertain the question; because, if any one curve of equal horizontal thrust was contained, it proved that the theoretical line of resistance was also contained. It would be observed, on referring to the paper and consulting the drawings and models, that the rules were general, and applied to every form of arch and archiform structure, loaded or unloaded, and whether of equal thickness or otherwise. The model, with the rectangular voussoirs leaning together at the apex, was selected as an extreme case. He wished to remove an impression, which might have been produced, by his stating that his mode of treating the subject of arches was not mathematical as that of Professor Moseley: he only alluded to the use of geometric construction instead of algebraic formulæ; the principle or theory was the same in both cases. The misapprehension as to assuming points in the curve, which Mr. Stephenson alluded to, as not having been sufficiently explained, arose from the modification which was necessary in applying theory to practice. If perfect hardness of materials and mathematical accuracy of workmanship were attainable, the pressure would be transmitted in the line of resistance, as laid down by Moseley, and described by Mr. Snell. On the other hand, if the materials were in the softest state in which it was possible for an arch to sustain itself, the pressure would be transmitted in that curve of equal horizontal thrust, which corresponded most nearly to a line drawn through the centre of the thickness of the arch; because in that state of the arch, the whole available surface of the voussoirs must be acting, to support the insistent pressure; practically, therefore, the pressure would be transmitted in a curve of equal horizontal thrust, somewhere between these two limits. Now, in the case of large brick arches, particularly when the centres were first struck, the state of the arch approached that which had been just mentioned, and it was for that reason he had stated in the paper, that in determining abutments for arches of large dimensions, the points p p' should be taken in the centre of the thickness of the arch, though the extreme limit of stability, if the materials were hard, would be when the points p p' were in the theoretical line of resistance. Assuming the points p p' to be in the centre of the thickness, and making the abutments accordingly, was in effect nothing more than providing abutments of such dimensions as should resist the thrust of the arch, when it was in the most disadvantageous state in which it was possible for it to exist. An arch constructed with abutments only just sufficient to contain the theoretical line of resistance, would possess the same degree of stability as a column placed so far out of perpendicular, that a vertical line drawn through its centre of gravity would just fall at the extremity of its base; but an arch, with abutments built so as to contain the curve of equal horizontal thrust, which accorded nearest to the centre line of its depth or thickness, would be under the same condition of stability as a column placed perfectly vertical.

CONSTRUCTION OF SEA WALLS.

Opinions of Engineers on the Construction of Sea Walls, referred to in Sir HOWARD DOUGLAS'S Protest, given in last month's Journal.

ANNEX (B).—Sir JOHN RENNIE on the Mode of Construction of the proposed Harbour.

With regard to the last important consideration, namely, the particular mode of construction, and the cost. Various plans may and have been proposed for this purpose, such as founding the substructure below low water in caissons, and raising a superstructure of perpendicular walls of masonry upon them, carrying out frame-works of timber or iron, and forming walls of masonry within them, filling the interior space between the walls with chalk or concrete; another plan consists in throwing down masses of chalk into the open sea, and covering them with stone of harder description. None of these, however, appear to me applicable to the purpose, particularly for the great outer mole or breakwater; the only similar examples where caissons have been employed, are the memorable cases of Cherbourg and Sheerness, where they signally failed. Wooden caissons and hollow circular towers, composed of brickwork, masonry, and timber combined, also wooden floating breakwaters, were proposed by General Bentham to be used in the construction of the breakwater at Plymouth, but after being fully discussed, these plans were abandoned as being inapplicable, and, looking to the particular circumstances of Plymouth Sound, the reasons given for the rejection of those plans were unanswerable. In such great and important works, where failure would be attended with most disastrous consequences, none but those means which are best recognised as certain of success should be adopted. This has been amply justified by the result of the mode adopted in the construction of the breakwater at Plymouth, which has completely succeeded in every respect, whether as regards design, construction, or economy, and I feel convinced that under those circumstances, no other system would have answered so well. Much has been said about the damage occasioned by storms disturbing the rubble; the fact is, storms form the principal agent in consolidating the rubble and save manual labour, and, to use the late Mr. Rennie's words, are the best workmen.

ANNEX (C).—Mr. GEORGE RENNIE'S Report on the Harbour in Dover Bay, and his Evidence.

With respect to the form and construction of the proposed breakwater. Experience has proved the principles of Cherbourg, Plymouth, and Kingstown Breakwaters. The destruction of the cones at Cherbourg, and the failure of the brick masses at Sheerness, are sufficient arguments against the adoption of caissons, or other expedients.

If such a work as is now proposed be undertaken, it should be solidly and properly done. The magnitude of such a work would not justify the risk of a failure; and, without entering into the question of the comparative cost and efficiency of different systems, I have no hesitation in pronouncing in favour of sloping stone breakwaters, similar to that of Plymouth; assuming, therefore, the same profile or section for the proposed breakwater as that, from 1,800 to 2,000 square yards, and the same prices which that work has cost, the probable amount will be about £3,500,000; in consequence of there being no good materials in the vicinity, they must be brought from elsewhere.

Ques. You have spoken of the experience you have had in constructing breakwaters, and of the observations you have made upon existing breakwaters; you have studied fully also the theory upon which the construction of breakwaters depends with respect to the action of the sea?—*Ans.* I have.

You have said that you consider upright walls not so capable of resisting the action of the sea as sloping; do you form that opinion upon the well-known theorem of the action of fluids in motion upon planes in terms of their obliquity?—*I do.*

And that as the obliquity increases the effect upon the wall is diminished in a very high ratio?—*It is.*

Do not the advocates of the upright system predicate their theory upon the supposition that waves in the open deep sea have only an oscillatory motion, direct and indirect, but that they have no progressive motion; that they do not act with any propelling or percussive force upon an erection in the sea?—*I believe they have that notion.*

And that the only motion is a vertical?—*Yes.*

And that, consequently, the only effect that waves produce upon the wall is by their statical pressure, or weight?—*I believe so.* But in answer to that, some experiments have been recently made upon the horizontal action of waves upon flat surfaces by Mr. Alan Stevenson. Mr. Stevenson showed me an instrument when I was in Edinburgh in June last, which consisted of a flat plane of a foot space, stuck upon the end of a rod, just like a letter balance, placed vertically to the shock of the sea. It had a spring behind it, and, of course, when a wave struck it, it indicated by the pressure against the spring the force of the wave. The action of a wave moves horizontally, and when it strikes an object, it does it with the mass of the wave put in motion, multiplied by its velocity. Consequently, in order to repel that wave, we must have a mass which shall be such that its weight shall be capable of resisting the shock. It must be equal, both by its adhesion and weight, to overcome the shock of the wave.

Do not you think that so far from a sloping breakwater creating the

force (as the advocates of the upright wall state) with which the water rushes up, it is the force with which the water does so rush up the plane, being thus permitted to expend and exhaust itself, which diminishes the effect in the horizontal direction upon the structure; and that if it were not so, as in the case of an upright breakwater, that force would act wholly like a ram upon the perpendicular wall, to overthrow it?—*It would; if we compare it with the friction of water in waves, which I have found by experience to be something like a third of the pressing or horizontal force, I should think by the same reasoning that the force of waves would be diminished in the same proportion, only that the friction of those large stones is much greater. I should say that the force by the great angular inclination of those stones would be diminished in the ratio of one-half the momentum or impulse of the shock.*

Is it not clear, then, that so far from waves having wholly an up and down motion upon the face of an erection in the sea, so far from their having no force in a horizontal direction, they do come in with propelling and percussive force, which does act horizontally against the erection, whatever it may be, with a force which varies according to the slope?—*I am quite of that opinion, and it is further confirmed by the forms which beaches take.*

The advocates of the upright breakwater do not dispute the hydraulic fundamental theory, that when fluids in motion act upon a plane, the force of the motion upon the plane diminishes in a high ratio in proportion to the angle of the plane, but they assert that this does not apply to the hydraulic construction which we are considering, because there is only an up and down motion. Do you or do you not consider that the construction of breakwaters, and their proper form, does depend upon that hydraulic theorem, and that it would not be safe to proceed to the construction of any breakwater upon the supposition that it is not governed by those laws, for that there is no horizontal motion, but only a vertical pressure?—*I think so. I think that the advocates of perpendicular walls are quite wrong, with all due deference of course.*

Do you think it is practicable, or would it not be exceedingly difficult to build an upright wall in the open sea, in seven fathoms water?—*I think it would be almost impracticable in deep water; I should be very sorry to undertake such a thing.*

Do you think, if undertaken, it would be safe to use any artificial or inferior materials, such as concrete or chalk, in any part of it?—*I do not, decidedly.*

Do you know any case in which an upright wall has been built in modern times in such deep water as that in which we propose to erect this breakwater?—*I know the case of Sheerness, where the masses were sunk to form an upright quay wall.*

Would not the erection of a breakwater, perfectly upright, in the open sea, in Dover Bay, in seven fathoms water, be an experimental measure?—*It would.*

Under all the circumstances of the case, confining yourself to the practical question, and especially considering the effect of failure, do you think in the natural roadstead and anchorage of Dover we should be justified in making such an experiment under such circumstances as these?—*I do not. Of course I may be a partisan of a particular system, but I give you my unbiassed judgment.*

ANNEX (D).—Mr. WILLIAM CUBITT'S Plan for the Construction of a Harbour of Refuge in Dover Bay.

The most obvious mode of construction, and possibly after all the best, is that of depositing large masses of rough hard rubble stone in the sea, in the line of the intended work, in the same manner in which the harbour of Kingstown and the breakwater at Plymouth were constructed. The simplest is tumbling large stones into the sea, as Plymouth Breakwater and Kingstown Harbour Pier; another mode is building in water with large stones, by means of the diving-bell; another by building caissons, filling them up partially, and floating them into their berths, and sinking them, and completing afterwards, either in or about them.

On the whole, therefore, after a most careful consideration of the subject, my recommendation to their lordships is, to form the harbour at Dover Bay with piers or breakwaters, constructed by depositing the largest blocks of either granite, Portland cap stone, or limestone, or all of them as may be procurable together, with all the small stone that may be procurable together, with all the small stone that may arise in quarrying the rough blocks; and to form the breakwaters with circular heads at each of the entrances 300 feet in diameter, brought up from the bottom with solid facings of ashlar masonry by means of the diving-bell after the harbour is enclosed, as is now being done at Kingstown Harbour.

Ques. Will you have the goodness to state, after such strong expressions in favour of an upright wall, why you now recommend a long slope?—*Ans.* The reasons I stated, that if in constructing a wall in the sea 72 feet high, which is the height we calculated upon in deep water, we could be sure of all our premises, the thing could be done, and would be the most perfect. I also stated, I think I recollect, in that report the reason I went from that and recommended another plan was, because I wished to recommend that which was perfectly certain to be effected with no contingencies, and at a much more easily ascertained cost than a breakwater with upright faces, which I certainly deemed the most perfect if done, but the casualties and unknown circumstances attending which rendered it doubtful in some points, and the expense of which would be greater. That in a thing of so large and important consideration as this harbour is, where millions of money, to say the least of it, must be expended, to do anything effectual,

in my opinion it is better to take that thing which we thoroughly understand and know, than to take a thing which is in the least degree experimental on such an immense scale.

You are, no doubt, aware of the tremendous disasters that attended the long slope at Plymouth during its progress of construction. With such facts as these before us, do you think the long slope can be safely adopted at Dover?—Quite so, and for very good reasons. It is not because a casualty happened from a great storm arising whilst the breakwater was building there, or because another happened afterwards, in which they took up 200,000 tons of stone, which is not a great quantity, that we are to conclude that the plan was not a good one. I believe that that breakwater was set about in an imperfect manner. The makers of Plymouth breakwater prided themselves upon taking all large stones for it, the breakwater consequently was too hollow, and when a heavy sea came it curled over the surface of the breakwater, covering it with the water, and the compression of the air inside drove up the stones. Now, if all the stuff that was raised in the quarries, large and small, had been put into that breakwater, I do not think that that quantity of stone would have tumbled out of it; and again, when a breakwater is fairly trimmed over, and trimmed into form, there is no difficulty in paving that with heavy stones on the edge, and giving it as perfect and smooth a face, after a little time, as can be, at any angle you please, so that no sea can break into it at all. It is because the thing is imperfectly done that it is not good. And with regard to casualties happening, I am sure I do not myself suppose, and I do not think any party in reason will suppose, that we can build an upright wall without having casualties; things will be tumbled head over heels, and we cannot work half the time, or sometimes a quarter of the time. We must have the benefit of experience in a great work of this kind; and, I think, there is not that experience for an upright breakwater yet to justify us in entering upon it to this extent in the first instance.

I will ask your attention to the different aspects of the two works, the Plymouth breakwater and that proposed at Dover. What will be the effect of its striking in that way upon those loose stones; will it throw them into the passage?—I would have none come out. But in completing the end of the rubble, if there were a thousand stones driven out they would be taken out, and it would be cleared out again in completing the ends with the diving bell, exactly as they are now completing the walls of Kingstown harbour.

You are aware that at Plymouth the entrances of the breakwater are at each end, but at Dover the entrances must be directly through the slope?—Exactly so. So it is at Kingstown harbour; and though the seas there are not equal to those at Plymouth Sound, they are at times uncommonly heavy seas, and I have seen a perfectly clear passage in the seven or eight fathom water. There is no difficulty about that.

Without going into the question of the principle of the action of waves on upright faces or slopes, you think that to build an upright wall in Dover Bay in the open sea, in seven fathoms at low water, exposed to the action of currents and tides, would be altogether a very difficult undertaking?—Upon any plan whatever.

And having bestowed upon this important question all the science and all the attention which you have devoted to it, and with all your experience, you come at length to this practical conclusion, that upon the whole, after the most careful consideration of the subject, your recommendation would be to form the harbour at Dover Bay by depositing blocks or masses of stone, as shown in the plan which accompanies your report, using the largest blocks either of granite, Portland stone, or limestone, so as to form a section, having a long fore-slope?—I do; but I not only do that, I give a statement at the same time of the dimensions of the thing, the quantity measured, and show what addition it would make in the cost of the whole, and what saving might be made by using other materials in its construction.

Then you think that any attempt to erect an upright wall from the bottom in Dover Bay, at the depth of seven fathoms at low water, and to form that wall of blocks of concrete, or any other artificial material would partake very considerably of an experimental undertaking?—Quite so.

And that we should not be justified in recommending or approving anything which is of an experimental character for this national work?—I think there would be great danger in undertaking a work of that kind upon an experimental or new plan. We are not sufficiently experienced beforehand, having no previous knowledge. There are very weeks in the year in which it is at all comfortable, being off Dover one mile or two miles at sea. It is all blind work at the bottom of the sea. People may think that they can put those down with scaffoldings, but what is to be done at 72 feet deep, with a diving bell, in the open sea, is very difficult to say.

ANNEX (E).—Mr. ALAN STEVENSON'S Answers to Questions proposed to him on the Mode of Construction.

You are considered to have bestowed much study and observation, and to have great practical experience as to the action of waves on erections in the sea?—I have had considerable experience in the erection of works exposed to the action of the sea, in piers, light-houses, harbours, and beacons; and I believe I have enjoyed good opportunities, more especially at the Skerryvore Rocks, of observing the action of the waves.

All my experience, observation, and consideration, lead me to believe that a sloping face is better calculated to resist the action of the waves than a perpendicular one, and the force expended against the perpendicular plane seems by concentration to become more intense, for the seas rise

to a greater height than those which strike a sloping face. Such an opinion is in accordance with the phenomena which characterise almost every part of the coast, where it is found that the angle of the shore varies with the force of the waves. I cannot imagine that the waves of the sea exert no percussive energy, when I observe their power in forcing forward a vessel which has neither wind nor tide to help her, or a vessel at anchor, an effect which I have felt in 12 and 18 fathoms water; or when I consider the height to which spray rises in deep water by striking a vessel at anchor.

That waves driven in by gales of wind are destitute of percussive effect I cannot conceive to be possible.

The force of the waves will be greatly diminished when they act obliquely on a sloping surface. From the effect of the slope to increase the surface of the wall opposed to a given perpendicular surface of the wave, the energy of the wave will necessarily be decreased in proportion as the impinging particles are spread over a greater surface. But the force of impact thus diminished in the ratio of the sine of the inclination of the surface to the direction of the fluid's motion, must, in order to estimate its tendency to displace the wall horizontally, be resolved, first, perpendicularly to the surface, and again in a horizontal direction, so as to be thus finally diminished in the ratio of the cube of the sine of the inclination of the surface of the wall to the direction of the wave. Experiments upon the action of fluids or surfaces confirm the view thus theoretically assumed.

I cannot perceive any material difference, in so far as the result is concerned, between the case of the breaking wave and that of an unbroken wave, except that I should expect more force in an unbroken wave which has not encountered an obstacle. Admitting that both have an onward movement (which I take to be the case with all waves which are acted on by the wind), it would appear to me that the direction of the force in a broken wave must be more diffused in different directions, and would thus seem to possess less of a "ram-like power."

What do you think of the theory which assumes that waves have no other action than static pressure upon a perfectly upright wall, although it is admitted that waves in a broken or breaking state have a percussive force, which an upright plane is not so capable of resisting as a slope, according to the well-known hydraulic theorem to which I have adverted?—My opinion of that theory is that it is not sound, and I found my conclusion on observation, and on reasoning, which both conduct me to the same result.

How can the hydraulic action or percussion of the wave, in the direction of its motion, cease when it comes in contact with the wall, and become hydrostatic pressure, without acting by impact on the wall which stops that motion, and which consequently, if it stands, resists that impulse?—I see no reason, as stated in the last answer, for supposing that the purely vertical or undulatory movement, which the above theory ascribes to all unbroken waves, should not produce, in the process of its neutralization by a vertical wall, effects similar in kind to those produced by its neutralization by an inclined plane. In both cases the undulation is checked; and whether this is done by reflecting the vertical or undulatory motion in one direction or another, seems in no way to change the measure of the whole shock, which such a concussion and final extinction of the force seems to imply.

Are you aware of any case in which a perfectly upright wall has been built in the open sea, in a depth of seven or eight fathoms?—I never heard of any upright wall being built in any such depth as seven or eight fathoms.

Would not such a mode of construction, applied to Dover Bay, be essentially an experimental measure?—Certainly, so far as my experience goes.

What is your opinion of the difficulty, facility, or practicability of building an upright wall in the open sea in such a depth of water? and how should you proceed to execute such a work?—I should consider building an upright wall from the bottom in seven or eight fathoms in an open seaway, like that at Dover, as a work of the utmost difficulty, if not indeed wholly impracticable.

Are you prepared, as a practical and experienced engineer, to recommend that such an experimental mode of construction should be tried in such a place, on such a scale, at an enormous cost, and for such permanent national objects as those to which these proceedings relate?—So far from recommending the trial of such a work, I should humbly, but decidedly, dissuade the government from such an attempt, which I am sure would end in failure.

What, upon the whole then, is the mode of construction which you would propose for executing this great work, in the most certain, solid, and enduring manner?—Taking into account the forms of the natural shore, and the tendency of the foregoing views, I see nothing to warrant a departure, in any material degree, from the existing practice of engineers in the construction of breakwaters.

What is your opinion of the action of the wave upon a perpendicular wall, with a smooth surface in deep water?—I cannot conceive that the unbroken waves caused by wind have less percussive force than when they are broken and diffused; I must conclude that the sudden check of this force by a vertical barrier will produce a greater single effect than the gradual expenditure of force over a larger space caused by meeting the successive surfaces presented by a sloping wall. The tendency, therefore, appears to me to be towards a more certain and rapid destruction of the vertical barrier than of the sloping one. The destruction of the sloping

breakwaters may either prove that the slopes were not sufficiently great, or that the materials composing them have been ill assembled, so as to cause vacuities between the stones, or, which is perhaps the most common cause of failure, the foundation of the glacis has not been laid at a low enough level, or, finally, that they have not been paved with stones of sufficient weight, nor united to each other with the care necessary to exclude the action of the water, which tends to remove this description of paving.

The analogy between the natural beach composed of loose materials and the face of a breakwater is not complete, because the materials with which a breakwater is to be paved may not only be larger than those which play about on a natural shore, but may have the additional advantage of being carefully assembled and united together. Again, it must be remarked that artificial works are exposed to greater risk from casualties than the natural beaches, from the following reasons: First, because the choice of their position is too often empirical in so far as their stability is concerned, and is primarily and sometimes almost solely determined, with reference to their fitness to produce an effect in stilling a basin or harbour, with only a secondary regard to the risks of injury which they may encounter. And, second, because, from motives of economy, such artificial works, so far from having slopes greater than those of the neighbouring beaches, are generally steeper, and, as before noticed, are too often deficient in solidity and in the careful protection of their surface by means of pitching.

From the general tenor of the answers you have given to Sir Howard Douglas's questions, you are of opinion that the unbroken wave has percussive force like the broken wave, and that, of the two, you consider the unbroken wave to have this force in a greater degree than the broken wave: will you be good enough to state how you account, therefore, for these facts on your theory?—I am of opinion that an unbroken wave has percussive force like a broken wave, and probably in a greater degree, because it has not sustained the same check or retardation. I believe that all waves, except the great tide wave, have an onward motion, because I know of no cause constantly in operation which is capable of producing waves but the wind, and this agent, it appears to me, must of necessity impress upon the waves some degree of onward motion. From all my experience I have invariably found that the sea broke gently and playfully on all the sloping walls, while it broke with a loud noise on the plumb walls, and raised the spray in some cases to the height of 30 feet and upwards. In striking against this perpendicular face the successive waves make a sound similar to that of a great gun at a distance, carrying sometimes with them large pieces of stone which, falling on a lighthouse roof, occasionally damage it; though at the distance of 240 yards from the face of the rock.

There is no analogy between the case of a pile which permits the sea to pass round it freely, and that of a continuous wall which checks its progress and opposes a long front of resistance. The mere circumstance of the in-shore piles being more injured than the outer ones, appears to me not very relevant to the subject under consideration.

As to the circumstance of the piles which were braced being more injured than those which were unbraced, this only proves that from the manner in which the braces were applied, they offered more resistance to the wave than was compensated for by the additional support derived from them. I have sufficiently shown that it is possible to explain the various circumstances adduced by Colonel Alderson on the view which I have taken of the percussive nature of all waves with which we have to do in the formation of breakwaters.

In my own mind I have no doubt that ocean waves are not purely oscillatory, but that all waves have an onward motion, and possess percussive force, and my humble conviction is, that the first attempt on a large scale to check the force of the waves in deep water, by means of a vertical wall, will prove a signal failure, and that a force will be developed by the collision of the wave with the wall, whose amount will be found to surpass anything which has hitherto been experienced on the face of a sloping breakwater.

I cannot look upon the works at Plymouth, Kingstown, and Cherbourg, each of which I have visited, as any longer merely experimental. Such works, may, on the whole, be considered as satisfactory as the nature of the circumstances will permit.

Do you think it impossible to construct a breakwater at Dover in such a manner, and by such methods, as would give it practically a monolithic character, and render it capable of resisting the force of the sea in the same manner as an upright cliff?—I have already expressed my belief that the waves have an onward motion, and that this motion would be continued until checked and thrown back by the action of the wall. The wall therefore must reverse the movement and annihilate the force on its onward course, and seems consequently obnoxious to sustain the final effort of the waves. I cannot see how in such a case any part of the water can be considered as at rest, and thus operating as a non-conductor of the force; and the facts alluded to in my former answers, which I have myself observed, as to the action of waves against cliffs, seem fully to corroborate my views.

ANNEX (F).—Mr. WILLIAM STUART, *Superintendent of the Plymouth Breakwater, on the Mode of Construction.*

I have been employed at the breakwater from the commencement of the work in 1811; but as superintendent only since 1829.

The slope, as left by the sea, from low water upwards, was about 5 feet horizontal to 1 foot perpendicular, and in some places rather more.

Messrs. Chapman, Jessop, and Rennie (the late Mr. John Rennie), engineers, were called in to report; and it was thereupon determined, in April 1825, that a breakwater should be formed regularly from the level of low-water spring-tides, with a casing of rough squared blocks of granite and limestone, commencing on the exterior, or south slope, with a slope of 5 to 1, as the sea had left it; and on the inner, or north side, with a slope of 2 to 1.

What was the object of increasing the breadth at the top?—To add to the stability of the breakwater.

Do you attribute the damages you have stated in the years alluded to, to the form and shape of the breakwater, and to the want of filling up the interstices?—In the first gales I attributed the damages to the fact that we had not length enough of foreshore, or of extension to seaward.

Not slope enough?—Not slope enough.

What was the objection you had to the more upright slope?—I was convinced it could not stand; and my belief was afterwards confirmed by the actual failure of a solid part of the breakwater, which had been built on this plan, and also by the failure of a part of Statten Pier itself, which had never to encounter anything like so severe a test as the breakwater.

Do you think if the breakwater had been constructed in any other form, for instance, if it had been either wholly upright from the bottom of the sea, or upright from about low-water mark, that such a breakwater would have had power to resist the force of the sea which overturned that large portion of it which you have mentioned?—I think not.

Do you think that oblique planes of breakwaters, built in the sea, are better calculated to resist the force of the sea in the direction of motion than any upright work?—I do, decidedly.

Having said you prefer a sloping breakwater, as best able to resist the force of the sea, you further state, from your own experience, you think the long slope of 5 to 1 is that which is most likely to remain in a state of stability?—I do.

I would begin by throwing in stones and getting the whole up to low-water mark, letting them find their own base in the first instance, with rubble stone, large and small together, and then that would become a protection, and the sea would level down and you could then add to it again.

Was any part of it ever made upright?—Never.

So that the upright building was never tried?—Never.

ANNEX (G).—Mr. J. M. RENDEL, *on the Mode of Construction, and Evidence.*

To construct a breakwater in seven fathoms water is, I apprehend, a very formidable undertaking, especially if any of the ingenious contrivances of caissons and machines of that kind are to be resorted to. I doubt very much, if a breakwater is to be constructed in seven fathoms water, whether the only safe plan would not be to deposit in the usual way from vessels (if it is a detached breakwater, or from a railway, if it is a breakwater connected with the shore, and the shore produces suitable materials), a mass of stone up to within, say, two or three feet of low water; and above that to construct perpendicular walls of the kind referred to in Col. Jones's letter of suggestions.

Considerable doubt being entertained as to the slopes, and particularly the sea-slope of a breakwater, as least likely to be damaged by the action of the waves, you are requested to state, on reading Col. Jones's paper upon this important subject, your opinion upon it?—I think Col. Jones would be very likely to fall into the same error in universally applying perpendicularly-sided breakwaters as other engineers have been of universally employing sloping ones. I think if the stones were thrown in and allowed to form their own slope, that slope being determined by the nature of the materials up to within two or three feet of low water, and then the breakwater raised upon that with perpendicular sides, it would be the most economical plan in most situations. I should be more disposed, if I had to build one in seven fathoms water, to adopt the plan I before referred to: suppose I had an unlimited command of materials, I should first of all begin to deposit those materials to form a rough mass up to within a moderate depth at low water, and then when I had brought my foundations up to that point at which the sea would begin to attack me, I should begin to attack the sea by building with a class of materials that would be its master. I think an upright wall in that case might be desirable.

In your evidence before the Commissioners last year on the difficulty of constructing works in seven fathoms of water, you deprecate the use of caissons, and expressed doubts whether a breakwater could be constructed in seven fathoms water by such means; do you retain that opinion?—I do.

You say you do not know of any instance in which a breakwater, with an upright face of the magnitude now contemplated, has been constructed in the open sea, in seven fathoms water?—I do not.

Then you say in another part, that if you had an unlimited command of materials, you would begin to deposit those materials so as to form a rough mass, with a slope up to about low-water mark, and upon that you would build a superstructure in the shape of an upright wall?—I should do so.

And you recommended this combination of the slope for the substructure with an upright wall for the superstructure?—I should so if I had suitable materials at hand.

Are you still of that opinion?—I am.

You stated that if you had plenty of materials at your disposal you

would be disposed to form the breakwater foundations below low-water mark with a slope, and above with an upright wall; was that as matter of economy or as matter of principle?—As matter of economy. It is quite a question of the cost. I have just finished a design for Holyhead Harbour; there, on account of the facility of getting rough masses of stone for the breakwaters, I have proposed to form them of rubble-stone up to low-water mark, with sloping sides.

If the execution of this work, with the brick blocks, were pressed on so rapidly as to render it necessary that those blocks should be made in remote places to be shipped or otherwise transported to Dover, would not a great part, if not the whole, of the economical advantage of using brick masses instead of stone disappear?—To a certain extent it would, but there is no county in England where brick earth more abounds than in Kent. In short, I am quite satisfied that you must have the material without bringing it by vessel; it must be brought by railway.

ON THE ACTION OF WAVES.

ANNEX (H).—Prof. AIRY'S Answers to Questions proposed to him on the Action of Waves.

Which form of structure is best adapted to resist the force of the waves, an upright wall or a breakwater with a slope similar to that at Plymouth?—In my judgment, an upright wall.

You have mentioned in a work which I have read with great attention and admiration, on the theory of waves, that the horizontal motion of the particles of water next the bottom, produced by waves in the sea, is found to extend to very great depths, and to occasion a sensible disturbance of stones and sand at the bottom, and that waves break over ridges or shoals, to the depth of 500 feet?—Yes; but in these instances the waves are very long.

Without entering on your theory of waves in the open deep sea, and confining my questions to your deductions from that theory, as to the practical effect of waves on erections in the sea, am I correct in saying you assume, that in deep water the motions of the particles are oscillatory, that the rising and falling of the surface of the sea depend on the horizontal movements taking place alternately in the same and contrary directions?—Yes.

That those displacements are represented by a periodical function, the sine or cosine of an angle depending on time?—Yes.

That this circular or elliptical movement of the particles is shown to take place only when a wave is transmitted along a channel of uniform breadth and depth?—Yes.

That as the depth of water becomes less, the waves become shorter?—Yes.

That their fronts become steeper?—Yes.

So that as they proceed into water of less depth, their faces become more and more perpendicular until they break?—Yes.

That waves in a broken state strike erections in the sea, in a manner to act powerfully and percussively, as hydraulic rams by their momentum?—Yes; when in a broken state they act percussively, not by the ordinary hydrostatic pressure.

Their mass and velocity give those waves that momentum or percussive force?—Yes.

For that reason, in the shallower parts of the proposed harbour, where the waves come into a depth at which, according to your theory, they would by breaking exert such a force upon the wall, you would recommend a sloping and not an upright wall?—I should. I think a sloping wall is best able to resist the action of the water in a broken state; and inasmuch as you cannot avoid the breaking of the waves, I should recommend a slope there; but in other parts, where you can avoid the breaking of the waves, I would have a perpendicular wall.

The waves become shorter and shorter as they advance, and, acquiring increasing tendency to break as they come into shallower water, their faces will be nearly vertical, in the state just preceding the broken state. Now, for the reason which you assign for thinking a sloping wall more capable of resisting the impact of a broken wave than an upright wall, do not you think that waves in heavy gales coming in with considerable velocity, and in that state, would act upon an upright wall with the percussive force due to their weight and velocity, and produce a more serious effect than if that impact were to act against a slope?—It will not strike at all. There will be a great swell up and down again; there will be nothing like horizontal motion.

The wave is proceeding?—It becomes a stationary wave; a combination of a direct and a reflected wave. It goes up and down again without breaking; it is merely an elevation of the surface. I have been in circumstances where I have had good opportunities of observing that practically, and I know that that is the case.

Then the modification you would propose is, that in the depth of water in which you think the wave would break, you would recommend a slope, and in the other part an upright face?—Yes.

In what depths, practically, would that be? I think you said the pilots can best answer that. You say that inasmuch as a wave does not break against an upright surface, it will exert no percussive force upon the wall?—No. It will exert the same sort of pressure that there is against a lock-gate; that is, a hydrostatic pressure.

Equal to the weight of a column of water, whose base is the surface pressed, and height the depth of the centre of gravity?—Yes.

On the Concave Face.—The construction would be exposed to less danger, if the section of the wall presented to the sea a hollow curve, like the base of the Eddystone lighthouse; but still there would be the breaking sea searching through every joint, and nothing can make square-stone masonry quite secure when it is exposed to this.

BRITISH ASSOCIATION.

The seventeenth meeting took place at Oxford on the 23rd June, when Sir Robert Inglis delivered an elaborate address, which we give in a condensed form.

SIR ROBERT INGLIS'S ADDRESS.

I begin with *Astronomy*.—The progress of astronomy during the past year has been distinguished by a discovery the most remarkable, perhaps, ever made as the result of pure intellect exercised *before* observation,—and determining *without* observation the existence and force of a planet; which existence and which force were subsequently verified *by* observation. It had previously been considered as the great trial and triumph of dynamical science to determine the disturbances caused by the mutual action of "the stars in their courses," even when their position and their orbits were fully known; but it has been reserved for these days to reverse the process, and to investigate from the discordance actually observed the existence and the place of the wondrous stranger which had been silently, since its creation, exerting this mysterious power. It was reserved for these days to track the path and to measure the force which the great Creator had given to this hitherto unknown orb among the myriads of the air.

I am aware that Lalande, more than fifty years ago, on two nights—which, if he had pursued the object then first discovered, would have been well distinguished from the rest of the year; and would have added new glory to his own name—did observe what is now fully ascertained to have been the planet Neptune; but though Uranus had just been added to those bright orbs which to mortal eyes for more than 2,000 years have been known to circle our sun, Lalande was observing before Piazzi, Olbers, and Harding had added Ceres, Pallas, Juno, and Vesta to that number, and before by those discoveries it was proved, not only that the planets round the sun had passed the mystic number of seven—since Herschel had confuted that ancient belief—but that others might also remain to reward the patient labours of other observers. He therefore distrusted his own eyes; and preferred to believe that he had been mistaken, rather than that the existence and force of a new planet had been reserved for the discovery of this latter age. What his eyes saw, but what his judgment failed to discriminate and apply, has since become a recognised fact in science.

I will not presume to measure the claims of the two illustrious names of Leverrier and Adams: of him, who, in midnight workings and watchings, discovered the truth in our own country, and of the hardly happier philosopher who was permitted and enabled to be the first, after equal workings and watchings, to proclaim the great reality which his science had prepared and assured him to expect. I will trust myself with only two observations: the one my earnest hope that the rivalry not merely of the illustrious Leverrier and of my illustrious countryman Adams, but of the two great nations which they represent, France and England, respectively, may always be confined to pursuits in which victory is without woe, and to studies which enlarge and elevate the mind, and which, if rightly directed, may produce alike glory to God and good to mankind: and the other, my equal hope, that for those (some of whom I trust may now hear me) who employ the same scientific training and the same laborious industry which have marked the researches of Leverrier and Adams, there may still remain similar triumphs in the yet unpenetrated regions of space; and that—unlike the greater son of a great father—they may not have to mourn that there are no more worlds to be conquered.

It is a remarkable fact that the seeing of the planet Neptune was effected as suddenly at Berlin by means of one of the star-maps which has proceeded from an association of astronomers chiefly Germans; such maps forming in themselves a sufficient illustration of the value of such Associations as our own, by which the labour and the expense—too great, perhaps, for any one individual—are supplied by the combined exertions of many kindred followers of science.

It is another result of the circulation of these star-maps, that a new visitor, a comet, can hardly be within the range of a telescope for a few hours without his presence being discovered and announced through Europe. Those comets which have been of larger apparent dimensions, or which have continued longer within view, have, in consequence, for more than 2,000 years been observed with more or less accuracy; their orbits have been calculated; and the return of some has been determined with a precision which in past ages exercised the wonder of nations;—but now, improved maps of the heavens, and improved instruments by which the strangers who pass along those heavens are observed, carry knowledge where conjecture lately dared not to penetrate. It is not that more comets exist, as has sometimes been said, but more are observed.

LORD ROSSE'S TELESCOPE.

An Englishman—a subject of this United Kingdom—cannot refer to the enlarged means of astronomical observation enjoyed by the present age without some allusion to the noble Earl, Lord Rosse, and his most won-

derful telescope. Its actual operations have been for a time suspended by a cause not less honourable to Lord Rosse in another character. They have been retarded, so far as he himself is concerned, by the more immediate duties, which, as a magistrate, and as a landowner, he owed to his neighbours, his tenantry, and his country, during the late awful visitation which has afflicted Ireland.

STAR CATALOGUES.

The Catalogues of Lacaille and of the *Histoire Céleste* are now before the world; and with the Catalogue of our Association constitute a series of most important gifts conferred on astronomy.

LUNAR THEORY.

The Astronomer Royal has done me the honour and the kindness, by a paper which I have just received from him, to make me the vehicle of communicating his wisdom to you on a most important and interesting discovery of the past year:—

"In the lunar theory a very important step has been made in the course of the past year. When, near the beginning of the present century, a considerable number of the Greenwich lunar observations were reduced by Bürg for the purpose of obtaining elements for the construction of his Lunar Tables, and generally for the comparison of the moon's observed place with Laplace's theory, it was found impossible to reconcile the theoretical with the observed places except by the assumption that some slowly varying error affected the epoch of the moon's mean longitude. From the nature of the process by which the errors of the elements are found, the conclusion upon the existence of this peculiar error is less subject to doubt than that upon any other error. So certain did it appear, that Laplace devoted to it one entire chapter in the *Mécanique Céleste*, with the title 'On an inequality of long period by which the moon's mean motion appears to be affected.' Guided by the general analogy of terms producing inequalities of long period, he suggested as its probable cause an inequality whose argument depends upon a complicated combination of the longitude of the earth's perihelion, the longitude of the moon's perigee, the longitude of the moon's node, and the moon's angular distance from the sun. But he made no attempt to calculate its theoretical effect. He also suggested an inequality depending on a possible difference in the northern and southern hemispheres of the earth. Many years elapsed before these suggested theoretical inequalities were carefully examined by physical astronomers. At length the introduction of new methods enabled Poisson and Lubbock successfully to enter upon the investigation of the theoretical values; and they proved that inequalities depending on the arguments suggested by Laplace could not have sensible values. The theory was now left in greater doubt than ever; and suspicion fell even on the accuracy of the reductions of the observations.

"A few years since, as is well known to members of the British Association, the British Government, at the representation of the Association, sanctioned the complete reduction, on an uniform plan, of all the observations of the moon made at the Royal Observatory of Greenwich since the year 1750; and the immediate superintendence of this work was undertaken by the Astronomer Royal. The reductions are now printing in all necessary detail; and the press-work is at this time very far advanced. In the last summer the corrections of the elements of the moon's orbit were generally obtained; and the errors of epoch in particular at different times were found with great accuracy. These results confirmed those of Bürg, and extended the law of the inequality to a much later time. In this state they were exhibited by the Astronomer Royal to Prof. Hansen of Gotha, who was known to be engaged in the Lunar Theory. Prof. Hansen immediately undertook a search for their theoretical causes. His perfect knowledge of the state of the existing theories enabled him at once to single out the class of disturbances produced by the action of the planets as that in which the explanation of this inequality would probably be found. In the course of a systematic search, many inequalities of long period were found; but none of sensible magnitude. At length two were found, both produced by the disturbing force of Venus, of a magnitude entirely unexpected. One depends upon the circumstance that eighteen times the mean anomaly of Venus diminished by sixteen times the mean anomaly of the Earth increases at very nearly the same rate as the mean anomaly of the Moon: its co-efficient is 27" and its period 273 years. The other depends upon the circumstance, that eight times the mean anomaly of Venus increases at very nearly the same rate as thirteen times the mean anomaly of the Earth: its co-efficient is 23" and its period 239 years. The combination of these two explains almost perfectly the error of epoch, which had so long been a subject of difficulty. The discovery of these two inequalities, whether we regard the peculiarity of their laws, the labours expended upon the investigations, or the perfect success of their results, must be regarded as the most important step made in physical astronomy for many years."

TIDES OF THE AIR.—TANGIBLE ASTRONOMY.

The doctrine of the influence of the moon and of the sun on the tides was no sooner established than it became eminently probable that an influence exerted so strongly upon a fluid so heavy as water could not but have the lighter and all but imponderable fluid of air under its grasp. I speak not of the influence attributed to the moon in the popular language and belief of nations ancient and modern,—of Western Europe and of Central Asia, in respect to disease; but of the direct and measureable influence of the moon

and of the sun in respect to the air. It is now clear, as the result of the observations at St. Helena by my friend Col. Sabine, that as on the waters, so on the atmosphere there is a corresponding influence exerted by the same causes. There are tides in the air as in the sea; the extent is of course determinable only by the most careful observations with the most delicate instruments; since the minuteness of the effect, both in itself and in comparison with the disturbances which are occasioned in the equilibrium of the atmosphere from other causes, must always present great difficulty in the way of ascertaining the truth—and had, in fact, till Col. Sabine's researches, prevented any decisive testimony of the fact being obtained by direct information. But the hourly observations of the barometer, made for some years past at the Meteorological and Magnetical Observatory at St. Helena, have now placed beyond a doubt the existence of a lunar atmospheric tide. It appears that in each day the barometer at St. Helena stands, on an average, four thousandths of an inch higher at the two periods when the moon is on the meridian above or below the pole than when she is six hours distant from the meridian on either side; the progression between this maximum and minimum being moreover continuous and uninterrupted:—thus furnishing a new element in the attainment of physical truth; and, to quote the expression of a distinguished foreigner now present, which he uttered in my own house, when the subject was mentioned, "We are thus making astronomical observations with the barometer"—that is, we are reasoning from the position of the mercury in a barometer, which we can touch, as to the position of the heavenly bodies which, unseen by us, are influencing its visible fall and rise. "It is no exaggeration to say,"—and here I use the words of my friend, the Rev. Dr. Robinson,— "that we could even, if our satellite were incapable of reflecting light, have determined its existence, nay, more, have approximated to its eccentricity and period."

ANIMAL ELECTRICITY.

In Physiology, the most remarkable of the discoveries, or rather improvements of previous discoveries, which the past year has seen, is, perhaps, that connected with the labours of the distinguished Tuscan philosopher, Matteucci. I refer in this instance to his experiments on the generation of electric currents by muscular contraction in the living body. This subject he has continued to pursue; and, by the happy combination of the rigorous methods of physical experiment with the ordinary course of physiological research, Prof. Matteucci has fully established the important fact of the existence of an electrical current—feeble, indeed, and such as could only be made manifest by his own delicate galvanoscope—between the deep and the superficial parts of a muscle. Such electric currents pervade every muscle in every species of animal which has been the subject of experiment; and may, therefore, be inferred to be a general phenomenon of living bodies. Even after life has been extinguished by violence, these currents continue for a short time; but they cease more speedily in the muscles of the warm-blooded than in those of the cold-blooded animals.

The delicate experiments of Matteucci on the torpedo agree with those made by our own Faraday upon the *Gymnotus electricus*, in proving that the shocks communicated by those fishes are due to electric currents generated by peculiar electric organs, which owe their most immediate and powerful stimulus to the action of the nerves.—In both species of fishes the electricity generated by the action of their peculiar organised batteries—besides its benumbing and stunning effects on living animals,—renders the needle magnetic, decomposes chemical compounds, emits the spark, and, in short, exercises all the other known powers of the ordinary electricity developed in inorganic matter or by the artificial apparatus of the laboratory.

ETHERIZATION.

This is the subject of the influence of the vapour of ether on the human frame—a discovery of the last year, and one the value of which in diminishing human pain has been experienced in countless instances, in every variety of disease, and especially during the performance of trying and often agonizing operations. Several experiments on the tracts and nerve roots appropriated respectively to the functions of sensation and volition have been resumed and repeated in connexion with this new agency on the nervous system. Messrs. Flourens and Longet have shown that the sensational functions are first affected, and are completely, though temporarily, suspended under the operation of the vapour of ether; then the mental or cerebral powers; and, finally, the motor and excito-motor forces are abrogated. It would seem that the stimulus of ether applied so largely or continuously as to produce that effect is full of danger—and that weak constitutions are sometimes unable to rally and recover from it; but that when the influence is allowed to extend no further than to the suspension of sensation, the recovery is as a general rule complete.

MICROSCOPISM.

In no department of the science of organized bodies has the progress been greater or more assured than in that which relates to the microscopic structure of the constituent tissues of animal bodies, both in their healthy and in their morbid states; and this progress is specially marked in this country during the period which has elapsed since the communication to the British Association by Professor Owen of his researches into the intimate structure of recent and fossil teeth.

The result of these researches having demonstrated the constancy of well defined and clearly appreciable characters in the dental tissues of each species of animal, (by which characters such species could be determined,

in many instances, by the examination of a fragment of a tooth,) other observers have been stimulated to pursue the same minute inquiries into the diversities of structure of the tissues of other organs. Such inquiries, for example, have been most ably and successfully pursued by Dr. Carpenter, in reference to the microscopic structure of recent and fossil shells; and the anatomist, the naturalist, and the palæontologist are alike indebted to the zeal and the skill of that eminent physiologist: while, in another sense, all are indebted to the British Association for aiding and stimulating his inquiries, and for the illustrations with which the publication of Dr. Carpenter's Report has been accompanied in the Transactions of the Association.

CAPILLARY ATTRACTION.—MOTION OF FLUIDS IN TUBES.

The hairs of the different mammalian animals offer to the microscopical anatomist a field of observation as richly and remarkably developed as the teeth, which formed the subject of Professor Owen's communication in 1838, and as the external coverings of the testaceous mollusca, which formed the subject of Dr. Carpenter's communication in 1846. The structure of the softer tissues of the animal frame has not been less successfully investigated by microscopic observers. One of the most extraordinary, perhaps, of the recent discoveries by the microscope is that which is due chiefly to Parkin and Valentin, and which in this country has been well established by Dr. Sharpey, relative to the important part in the motion of fluids on internal surfaces, performed by the vibratile action of myriads of extremely minute hairs or cilia which beset those surfaces. These ciliary movements, for example, raise the mucus of the wind-pipe to the throat against gravity. They have been detected in the ventricles of the brain, as well as many other parts.

The beautiful discoveries of Sir David Brewster have been carefully confirmed; and many interesting varieties have been noticed in the structure of the crystalline lens of the eyes of different species of animals.

The most brilliant result, perhaps, of microscopic anatomical research has been the actual observation of the transit of the blood from the arteries to the veins; the last fact required—if, indeed, such an expression be allowable—for the full proof of Harvey's doctrine of the circulation of the blood. Malpighi first observed the transit in the large capillaries of the frog's web. It has since been observed in most other tissues, and in many other animals.

No part of the animal body has been the subject of more, or of more successful, researches than the blood itself.

MOLLUSCS.

In no department of the living works of the Creator has progress been more manifested than in that humble and, therefore, heretofore much neglected, class of the molluscous or gelatinous animals which people the seas around our island. Among the naturalists who have rescued this branch of zoology from neglect, the name of Edward Forbes deserves early and honourable mention.

STEAM NAVIGATION AND BOTANY.

In the diffusion of the riches of the vegetable world, steam navigation has obviously been a most favourable auxiliary; so that "even cuttings of plants" are now "actually sent successfully to Calcutta, Ceylon, &c." In speaking of the exports from Kew, it is not unfitting to add, that "between four and five thousand plants of the famous Tussac grass have been dispersed from the Royal Gardens at Kew during the past year."

FECUNDATION.

In Vegetable Physiology, microscopic observers have of late been much occupied in investigating the phenomena of fecundation, and especially as to the mode of action of the pollen. On this subject, botanists are still divided. Several experienced observers adopt the theory lately advanced and ingeniously supported by Prof. Schleiden, of Berlin; while others of great eminence deny the correctness on which this theory is founded. Among these, the celebrated microscopic observer, Prof. Amici, of Florence, very recently in an essay—communicated to the Scientific Meeting held in 1846 at Genoa—has endeavoured by a minute examination of several species of Orchids to prove the existence of the essential part of the embryo anterior to the application of the pollen, which, according to him, acts as the specific stimulus to its development.

This view receives great support from some singular exceptions to the general law of fecundation. Of these, the most striking occurs in a New Holland shrub, which has been cultivated several years in the Botanic Garden at Kew; and which, though producing female flowers only, has constantly ripened seeds from which plants have been raised perfectly resembling the parent:—while yet there is no suspicion either of the presence of male flowers in the same plant, or of minute stamens in the female flower itself, nor of fecundation by any related plant cultivated along with it. This plant has been figured and described in a recent volume of the Linnean Society's "Transactions," under the name of *Calebogyne ilicifolia*, by Mr. J. Smith, the intelligent curator of the Kew Garden,—by whom, indeed, this remarkable fact was first noticed. It is not the least curious part of the history of the *Calebogyne* that male flowers have lately been discovered in New Holland unquestionably of the same species. Prof. Gasparini, of Naples, has more recently communicated to the scientific meeting held in that city in 1845 his observations and experiments on the cultivated fig,—which, though entirely destitute of male flowers, produced seeds having a perfectly developed embryo, independent of fecundation: access to the

pollen of the wild fig, generally supposed to be carried by insects, being in his experiments, prevented by the early and complete shutting up of the only channel in the fig by which it could be introduced.

POLITICAL AND SOCIAL INFLUENCE OF THE ELECTRIC TELEGRAPH.

Distance is time; and when by steam, whether on water or on land, personal communication is facilitated, and when armies can be transported without fatigue in as many hours as days were formerly required, and when orders are conveyed from one extremity of an empire to another, almost like a flash of lightning, the facility of governing a large state becomes almost equal to the facility of governing the smallest. I remember, many years ago, in the *Scotsman*, an ingenious and able article showing how England could be governed as easily as Attica under Pericles: and I believe the same conclusion was deduced by William Cobbett from the same illustration.

The system is daily extending. It was, however, in the United States of America that it was first adopted on a great scale, by Prof. Morse in 1844; and it is there that it is now already developed most extensively. Lines for above 1,300 miles are in action; and connect those States with Her Majesty's Canadian provinces; and it is in a course of development so rapid, that in the words of the Report of Mr. Wilkinson to Sir W. E. Colebrooke, the Governor of New Brunswick, "No schedule of telegraphic lines can now be relied upon for a month in succession, as hundreds of miles may be added in that space of time. So easy of attainment does such a result appear to be, and so lively is the interest felt in its accomplishment, that it is scarcely doubtful that the whole of the populous parts of the United States will, within two or three years, be covered with a telegraphic network like a spider's web, suspending its principal threads upon important points along the sea-board of the Atlantic on one side, and upon similar points along the Lake Frontier on the other."—I am indebted to the same Report for another fact, which I think the Association will regard with equal interest: "The confidence in the efficiency of telegraphic communication has now become so established, that the most important commercial transactions daily transpire, by its means, between correspondents several hundred miles apart. Ocular evidence of this was afforded me by a communication a few minutes old between a merchant in Toronto and his correspondent in New York, distant about 632 miles." I am anxious to call your attention to the advantages which other classes also may experience from this mode of communication, as I find it in the same Report. When the *Hibernia* steamer arrived in Boston, in January 1847, with the news of the scarcity in Great Britain, Ireland, and other parts of Europe, and with heavy orders for agricultural produce, the farmers, in the interior of the States of New York,—informed of the state of things by the Magnetic Telegraph—were thronging the streets of Albany with innumerable team-loads of grain almost as quickly after the arrival of the steamer at Boston as the news of that arrival could ordinarily have reached them.—I may add, that, irrespectively of all its advantages to the general community, the system appears to give already a fair return of interest to the individuals or companies who have invested their capital in its application.

The larger number of the members of this Association have probably already seen in London an exhibition of a Patent Telegraph which prints alphabetical letters as it works. Mr. Brett, one of the proprietors, obligingly showed it to me; and stated that he hoped to carry it into effect on the greatest scale ever yet imagined on the American Continent. Prof. Morse, however, does not acknowledge that this system is susceptible of equality with his telegraphic alphabet for the purpose of rapid communication; and he conceives that there is an increased risk of derangement in the mechanism employed.

I cannot refer to the extent of the lines of the electric telegraph in America without an increased feeling of regret that in our own country this great discovery has been so inadequately adopted.

In England, indeed, we have learnt the value of the electric telegraph as a measure of police in more than one remarkable case: as a measure of government it is not less important;—from the illustration which I have drawn from America, it is equally useful in commerce; but as a measure almost of social intercourse in the discharge of public business it is not without its uses also. But a few days since, I had an opportunity of examining the telegraph in the lobby of the House of Commons, by which communications are made to and from some distant committee-room. As a specimen of the information conveyed from the House is the following:—"Committee has permission to sit until five o'clock;" and among the questions sent down from the Committee are the following:—"What is before the House?" "Who is speaking?" "How long before the House divides?"

SMELTING BY ELECTRICITY.

For that process, I believe, a patent has been recently taken out. As yet, perhaps, sufficient time has not elapsed to test its full value. We all know that an experiment succeeds perfectly in the case of a model, or in a laboratory, which may not succeed so perfectly when the miniature steam engine, for example, is extended to its ordinary size in a manufactory, or when the operation is transferred from ounces to tons. But if the hopes, expectations, and confidence of the discoverers be realised, their plan will be of the greatest value to this country, and of even greater proportionate value to some of the Queen's most important colonies. It has been said that 16,000 tons of copper ore were sent last year from Australia to be smelted in England; and that they produced no more than 1,600 tons of copper. It is evident, therefore, that, if by this process of smelting by electricity,

the refuse, namely, 8,400 can be left on the spot, 8,400 tons of shipping are liberated for other purposes of commerce between the colony and the mother country; and the saving of coal in England, an object not wholly devoid of interest, is immense.

BRITISH MUSEUM.

Our National Collection may now be compared, not ostentatiously, but thankfully, with those of other countries; remembering, also, that our collections are little more than half a century old. The ornithological, the conchological, the mammalian departments in the British Museum are equal, I believe, to those of any other capital: greatly owing to the talents and labour of the eminent head of that department, Mr. Gray,—whom I see here. The fossil divisions, under the care of my zealous, laborious and able friend, Mr. König, are perhaps superior—in some classes, beyond comparison. Last year, there was added to the palæontology of the Museum the unique specimens of the *Holtherium* of Kaup, the *Cephalaspis* of Lyell, the *Lepidote* of Fitton; and the collection of osteology is, as it ought to be, the first in England. The number of visitors, which six years ago was 319,000, was last year above 700,000—and the collections of comparative anatomy in the Hunterian Museum are, as they ought to be, the first in the world.

The following are some of the more interesting papers read in the various Sections of the Association, for which we are indebted to the *Athenæum*.

"*Report on Geological Theories of Elevation and Earthquakes.*" By W. HOPKINS.

This lengthened report embraces too wide a range to admit of our giving at present any detailed analysis. After having stated certain leading characters of volcanoes, both with reference to the fluid volcanic mass and its containing cavity, the author proceeds to the examination of theories of volcanoes. He regards the *chemical theory* proposed by Sir H. Davy, and the theory more recently proposed by M. Bischoff, as involving mechanical difficulties of the gravest character. In considering the theory which supposes existing volcanoes to owe their origin to the former fluidity of the earth, the author is led to the discussion of the general theory based on the hypothesis of such fluidity. He examines the evidence afforded in favour of this hypothesis by the accordance between the present ellipticity of the earth, as determined by admeasurement, and its mean density as determined by the experiments of Cavendish and Baily, and the calculated value of their quantities. He then proceeds to consider the mode of the earth's refrigeration and consequent solidification, and the probable extent to which the latter process has already proceeded. Supposing the earth to consist of a fluid central nucleus and a solid envelope, it is concluded that the thickness of the latter is probably not less than one-fourth or one-fifth of the earth's radius. This conclusion is drawn from the observed amount of the precession of the earth's pole with that calculated on the hypothesis just stated, respecting the constitution of the earth; but the author also indicated another method by which evidence might be obtained on this point. He showed that if it could be proved by experiment that the temperature of fusion of solid substances is generally increased, even in a small degree, by high pressure, we should have strong reason to believe in the entire solidity of the earth; and if, on the contrary, it should appear that high pressure has no such effect on the temperature of fusion, we should be led to conclude that the present temperature of the earth is not due to its original heat. He considered such experiments necessary for the further advance of this branch of geology.

The second part of the report contains a theoretical investigation and examination into the nature and properties of the mechanical effects which would result from the action of such forces. The author proposed to consider the subterranean force as having the nature of an explosion, producing vibrations over a much wider space than that to which the original force was applied. The vibrations were compared to those produced by striking the end of a solid bar—which are of two kinds. The first set are similar, but infinitely less in extent to vibrations in air. They are produced by compression, and proceed in the direction of the axis of the bar. The second kind are perpendicular to the axis of the bar—like the vibrations of a musical chord. In this case the particles of the bar change their form, and the elastic force depends upon their tendency to resume their original shape. The velocity with which vibrations are propagated in the direction of the axis, is much greater than when their direction is transverse; and as both usually co-exist, they will after a time separate and become distinct,—both the velocity and the length of the waves of vibration being different. If the original impulse, or earthquake shock, is communicated at some distance below the surface, the vibrations produced may be compared with the disturbance produced in water by blowing up a wreck. A wave will be produced by the alternate compression and dilation of the particles, which will diverge in spheres, equally in all directions, with a constant velocity. In the earth, however, as in the solid bar, there will be two spherical waves proceeding outwards with unequal velocities. The apparent motion of these waves, when they reach the surface, will be different, from their real amount of motion below, depending upon the distance of the place of observation from a point immediately over the focus or origin of the force. Assuming the interior of the earth to be homogeneous, and the vibrations produced by earthquakes to be of the kind described, it becomes a leading point to ascertain, by observation, the position of the focus from which the vibrations

originated. On this subject nothing at present is known. Mr. Hopkins stated, that if self-registering instruments of sufficient delicacy were placed at two stations in a country subject to earthquakes, the direction of the vibrations would show immediately the point on the surface from which they originated. The depth beneath the surface might also be calculated, from the difference between the apparent movement of the wave on the surface and its real movement in the interior, as given by theory; or it might be ascertained by comparing the relative apparent motion of two waves proceeding with unequal velocities, if means were obtained for recognising the two kinds of waves by instruments indicating the nature of the vibrations.

Sir H. DE LA BECHE observed, that if the focus of the earthquake were near the surface, the problem would become one of great complexity, on account of the many breaks in the strata, and their difference of composition; but if the focus were several hundred miles below the surface, these inequalities would be of no consequence.

Mr. Mallet enumerated the different kinds of waves which do, or may take place, with every earthquake. When the focal point is inland, there will be the shock-wave, either single or double; the sound wave in the earth; and the sound wave in the air, if the original impulse is accompanied with fracture: if the superficial vibration is sufficient, there will also be the sea-wave. When the focal point is under the sea, as in all great earthquakes, there will be the shock-wave, the sound-wave under the sea, the sound-wave in the air, the great sea-wave, and a smaller, termed the "forced sea-wave;" if, however, there is no fracture, there will be no sound-waves. It had been ascertained that magnetometers were also "seismometers" of a very delicate kind,—those at Dublin having indicated from 10 to 20 shocks last year.

"*Report on Atmospheric Waves.*" By W. R. BIRT.

The author in introducing his fourth report on this subject observed, that in accordance with the resolution adopted at the last Meeting of the Association, about thirty sets of observations had been obtained from various stations in the British islands; the extremes of the area embraced being the Orkneys and Jersey in one direction and Galway and Dover in the other. As instances of the increasing interest manifested on this subject, he remarked that he had been furnished with curves from stations in the north, where the barometric movements had been considered to result from the transit of the great November wave. Each of these curves was referred to the same period; namely, from the 2nd to the 17th of November; and the observers invariably regarded the regular rise and fall that occurred between these epochs as indicating a well-marked return of the great symmetrical wave. Mr. Birt, after noticing the remarkable circumstances under which the wave returned last autumn—so remarkable that they had no small tendency to mark the wave in the south-eastern part of the island—stated that the projected curve at London strikingly developed its essential features; the *five* subordinate waves were well seen, although the inflexions were not strong, owing to the small altitude of the wave on its last return, scarcely exceeding half an inch—its whole development occurring above thirty inches prevented the boldness of the inflexions particularly noticed on the occasion of its return in 1842. The author then proceeded to notice the essential features of the curves as obtained from observations at Ramsgate, St. Vigean's near Arbroath, east coast of Scotland, the Orkneys and Western Isles, Applegarth Manse, Dumfries-shire, Largs, Limerick, Galway, Helstone in Cornwall, and St. Helier's, Jersey. Our limits will not permit us to give in detail the resemblances and differences of these curves, exhibiting, as they do, the distribution of pressure around Great Britain and Ireland, which the author traced from the south-eastern point towards the north-west; but the report will be printed in the forthcoming volume of the Transactions. We may, however, here notice that attention was called to the principle which the author laid down in his report of last year, "that the barometric curve, including a complete rise and fall at any one station, does not represent any reality in nature, but is the effect of two or more systems of waves or currents moving in different directions and crossing each other at various angles." He also pointed out the great extent of oscillation (nearly double) observed in the north-west as compared with the south-easterly observations. The great wave commenced on the 2nd of November; at the northern stations it culminated on the 12th; at the south-eastern on the 9th; and it terminated on the 17th. In explaining the differences of epoch as indicating the transit of the crest being much earlier in the south-east than in the north, Mr. Birt remarked that the observations clearly showed that the barometer passed *two* maxima, one on the 9th, the other on the 12th; and that the whole extent of the British Isles might be divided into *two* barometric areas, distinguished in one case by the superiority of the maximum of the 9th, and in the other by the superiority of the maximum of the 12th. A line passing between Arbroath and Newcastle, south of Dumfries, and between Ireland and Wales, separates these areas. North-west of this line we find the maximum of the 12th superior: south-east of it we find the maximum of the 9th superior. The maximum of the 9th Mr. Birt regarded as the central wave forming the crest of the great wave, and the maximum of the 12th he considered as the crest of the first subordinate wave on the posterior slope. The author next proceeded to examine the distribution of pressure as manifested by these observations; from which, in connexion with the features of the projected curve, he deduced the following results:—1st. The return of the great symmetrical wave. This occurred in the south-eastern angle of our island under very peculiar circumstances. The area of greatest symmetry is closely in accordance with the results of former discussions, and goes far to confirm the result deduced

from the examination of Sir John Herschel's hourly observations, "that Brussels is entitled to be considered as a point of comparatively gentle barometric disturbance, * * * and may be regarded as in a certain sense a nodal point, where irregularities are smoothed down and oscillatory movement in general is more or less checked, and such movements increase as we recede from Brussels as a centre, especially towards the north-west." The curve of greatest symmetry was obtained from Ramsgate, the nearest station to Brussels. As we proceed towards the north-west, the symmetry is considerably departed from, especially by the greater development of the first subordinate wave on the posterior slope, by which the maximum of the 12th became superior. This portion of the wave formed a striking contrast to the similar portion in 1845, which was characterised by a considerable depression. It is not a little curious, remarked the author, and goes far to show that we are approaching the true explanation of the nodal character of Brussels to observe that movements so dissimilar in their character, so opposite in their value, and presenting themselves under such a diversity of aspects, should, in a certain locality and on particular lines of country, manifest, by means of the barometer, constant and well defined phenomena, that may be recognised year after year, and which give to the curves of barometric rise and fall during the period of their occurrence a peculiar symmetrical appearance. 2nd. Two systems of waves or currents, one having a general direction of progress from the north-west, the other from the south-west, traversed the area during the period of the great wave. This is the same result to which we were conducted by an investigation of the symmetrical wave of 1842. The relative positions of the individual waves were somewhat different from those of the wide bi-dual waves of 1842; but there were some striking points of resemblance. The north-westerly system in each case exhibited the largest wave, both as regards amplitude and altitude. The intervals between similar phases of north-westerly waves were nearly equal in 1842 and 1846. During the interval that elapsed between transits of these similar phases in 1842 and 1846 the same number of south-westerly waves passed over the area—and from the whole it appears highly probable that we have not only ascertained another return of the great symmetrical wave (the sixth) but have also detected the return of at least three of the individual waves contributing to its production. 3rd. The very precipitous fall of the barometer characterising the posterior slopes of the north-westerly system, as developed by the discussion of the observations of 1842, is fully confirmed: in connexion with this, the decrease of oscillation from the north-west towards the south-east is also strikingly developed, as on former occasions. The author, in alluding to the area over which these observations extend, remarked that the British Isles present a far too limited area for the purposes of examining thoroughly these atmospheric movements; he observed that in the more extensive examination which the movements of November, 1842, are now undergoing, there are four stations at which the barometric changes are of an opposite character during the first eight days of November,—namely, Christiana and St. Petersburg in the north, and Paris and Geneva in the south. The curves at St. Petersburg and Geneva present the most decided opposition; rising at the one while falling at the other. The turning point in each case occurred on the 5th. These opposite movements he conceived to be occasioned by the opposite slopes of two waves passing from the south-west, and that the half breadth of each wave extended at least from Geneva to St. Petersburg. Such being the extensive character of the waves in question, in order to judge them in their totality it will be absolutely necessary to enlarge the area of observation. The centre of Europe is well dotted over with barometers, from which accurate results may be obtained; but even the British Isles, in connexion with that portion of Europe now under observation, form but a small part of the vast space over which the waves themselves extend. St. Petersburg is an important northern station, from which we have most excellent observations; but we require them also from Iceland, the northern parts of Norway, Sweden and Lapland, and also from Archangel in one direction, and from the southern parts of France, from Spain, Portugal, and the northern parts of Africa in the other; also from the Mediterranean they would be highly important. Observations stretching from the most western point of Africa to the extreme north of Europe would go far to determine the longitudinal directions of the north-westerly systems of waves. In reporting the general progress of the inquiry, Mr. Birt stated that we are now in possession of materials for examining the great symmetrical wave, not only in particular years, as 1842, 1845, and 1846, but also over the central parts of Europe and the dominion of the Russian empire, as far as Sitka, on the north-west coast of America. He has combined observations extending from the west coasts of Ireland and the Orkneys on the one hand, to St. Petersburg and Geneva on the other; and he apprehends that the whole of the barometric movements over this area, which occurred during the first eight days of November, 1842, are fully explained by the transits of two large waves on two sets of parallel beds of oppositely directed winds—one from the south-west, the other from the north-west. The continuation of the investigation will be, submitted at future meetings of the Association. In connexion with this, the author observed that a most important point appeared to be developing itself by means of these observations. Those from the north-west appeared strongly to indicate that somewhere in that direction the origin of the great barometric disturbances (a centre of oscillation) giving rise to the waves that pass onwards towards the south-east is to be sought. We have already obtained the nodal point of the two great systems of European barometric undulations—namely, Brussels. Between the Orkneys, which appear to be the nearest station to the north-west centre of oscillation, and Brussels the greatest decrease of oscillation occurs.

This line of the greatest diminution of oscillation appears to be well determined. The author closed his report with an allusion to the American system of atmospheric waves, especially those that accompanied the great Cuba hurricane of October, 1844, which has formed the subject of an elaborate investigation by Mr. W. C. Redfield, of New York; and was of opinion that the revolving storm, so ably brought to light by Mr. Redfield's labours, was produced by the crossing of two large long waves moving in different directions, as suggested by Sir John Herschel in his "Report on Meteorological Reductions," presented to the Association in 1843.

"On the Decomposition of Water." By Dr. ROBINSON.

The affinity which combines the elements of water is lessened by any increase of temperature above that of the atmosphere, up to 202°. If the intensity exerted in opposition to that of a battery by water during electrolysis be measured, and again when the voltameter is heated, it is found to decrease. In the first instance, its measure referred to my particular standard, as deduced from a mean of 12 sets is 598.9, temperature 61° 2'. The next by a mean of 13 gives

$$e = 567.5 \dots t = 135^{\circ} 4'$$

and the third mean of 12

$$e = 531.0 \dots t = 201^{\circ} 2'.$$

Applying to these the theory of probable errors, so successfully used in other branches of science, I find it is more than 10,000 to 1 that the difference thus shown is not all error of observation, and an even bet that it is not 5 wrong. The expression of e is affinity of platinum for oxygen, minus twice that of hydrogen, or

$$e = o.p - 2 o.h$$

and from this I compute that $o.h$ changes 23.2 for 100°.

This process is confirmed by a different process. The formula for the intensity of zinc and copper excited by dilute sulphuric acid is

$$E = o.z - o.cu - o.h$$

In Daniell's cell you substitute $o.cu$ for $o.h$, and have

$$E' = o.z - 2 o.cu.$$

In the latter instance, E' undergoes no change by heating the cell to 163°. The metallic affinities therefore do not vary within that range. But in the former E increases by heat, caused by the diminution of $o.h$, and it gives the change = 27.9 for 100°; the mean of all being 25.1. It is curious that if this rate were uniform, the temperature of decomposition by heat would be 2386°. In these experiments the conducting power of the electrolyte is greatly increased by heat. The only objection which I see against this conclusion is, that perhaps these effects may be due to the action of heat in facilitating the escape of gases. An experiment which I made seems to oppose this. If the apparatus be placed under the air-pump, the removal of pressure should show a similar change. This is not the case: when it is reduced to 1 inch of mercury, the measure of e remains unchanged. I think this a very curious result; it is quite the reverse of what I expected, for I had supposed heat would exalt these affinities up to a certain point, and afterwards that its action would change character. But its influence seems here always an antagonist to affinity. How then does heat ever produce the combination? The remark of Davy that hydrogen cannot be made to burn except by contact with a solid heated so as to be luminous, makes me conjecture that light is the agent which produces the molecular change of the three volumes of mixed gases into two of steam.

"On the Precipitate caused in Spring and River Waters by Acetate of Lead." By Prof. CONNELL.

Nearly all well and river waters are known to yield a white precipitate with acetate of lead. This precipitate is rarely due to any chloride, as silver salts have too little action to countenance such an explanation; and its ready solubility in acetic acid shows that it is not caused by sulphates, unless in so far as it is not dissolved by that acid. The ordinary course I have ascertained to be the presence of carbonate of lime; but the remarkable fact is, that the reaction both of the acetate and of the acetic acid takes place even after the water has been boiled and filtered, so that carbonate of lime remains dissolved independently of the presence of carbonic acid. The waters referred to yield carbonate of lime when evaporated, after having been boiled and filtered. To ascertain whence this carbonate of lime has proceeded, I passed a current of carbonic acid through lime water, till the precipitate at first formed was redissolved, and then boiled and filtered the liquid; but it did not affect lead salts to the same extent as common waters do. Neither did distilled water which had been left some days in contact with finely pounded marble. I incline to think that the origin of the dissolved carbonate of lime is double decomposition between an alkaline carbonate and a soluble lime salt; and have found, in all waters yielding the reaction, alkalies united to acids. The common water of the town of St. Andrews contains $\frac{1}{10000}$ of carbonate of lime after being boiled and filtered. It also contains a trace of carbonate of magnesia, which substance may occasionally be, in part, the cause of the reaction referred to, although to a far less extent.

"On the Cause of Evaporation, Rain, Hailstorms, and the Winds of Temperate Regions." By G. A. ROWELL.

Mr. Rowell stated his opinion that amongst the variety of theories given there is none that will fairly explain all the phenomena of evaporation. The theory of Dr. Hutton on rain may be thought sufficient to account for moderate rains, but totally fails when applied to such heavy rain as that which fell in London, August 1st, last year. Mr. Rowell endeavoured to show that the phenomena of evaporation, clouds, rain, lightning, hail, the

winds of temperate regions, and storms of lower latitudes, may be fairly explained by the hypothesis he submitted; *i. e.* electricity having no weight and diffusing itself equally over the surface of bodies, the minute particles of water, even in their most condensed state being completely enveloped in their natural coating of electricity, occupy, together with their electricity, nearly the space of an equal weight of air, and are thus rendered sufficiently buoyant to be carried away by the wind; but that when expanded by heat their specific gravity being then reduced, and their capacity for electricity being increased by the increase of surface, they are then buoyed up into the air by their electrical coatings; that when the rising particle is condensed it becomes surcharged by the contraction of its surface; if this takes place near the surface of the earth, the surcharge escapes and the particles fall as dew; but if it is condensed when above the electrical attraction of the earth, it is still buoyed up by the electricity, and on the escape of the surcharge, the particles attract each other and form clouds and rain. Hills and mountains cause clouds and rain by conducting the electricity from the vapour, and not by condensing it; and on these grounds he again suggests, as a test of the theory, the experiment he proposed to the British Association in 1840, *i. e.* "To cause rain by raising electrical conductors to the clouds by the aid of balloons." In support of the proposition he read an extract from a letter he received from Mr. W. H. Weeks, of Sandwich, dated Dec. 27, 1842, in which that gentleman assures him that "It has several times happened that when his electrical kite has been raised immediately under a distended, light, fleecy cloud at a moderate elevation, and a free current of sparks has passed from the apparatus for some ten or twelve minutes, he has suddenly found himself bedewed with a descent of fine misty rain, and on looking up has seen the cloud upon which he was operating surprisingly reduced in magnitude." Electrical kites cannot reach the clouds, and can only be raised in windy weather, when the clouds must be every instant passing away from the influence of such apparatus; and if they have such effects, what may we not anticipate from the use of conductors which would reach the clouds, and could be raised in calm weather? Mr. Rowell considered that from the reduction of temperature at the height of the clouds, the vapour in those regions must be always condensed, but invisible from being so diffused; and that the formation of clouds is not owing to condensation, but to the escape of electricity allowing the particles of vapour to attract each other. In support of these views, and also to show that the ascent and support of vapour at great heights must depend on some agent which is independent of heat or cold, he exhibited the table following—

Heights.	Temperature of Air.	Water heavier than Air.
Level of the Sea	+ 60°	860 times.
1 mile	+ 43	1,083 "
2 miles	+ 26	1,363 "
3 miles	+ 9	1,716 "
4 miles	- 8	2,160 "
5 miles	- 25	2,710 "

Another cause of rain is the pressure of the particles of vapour upon each other; for if a cloud be of great depth, say the lower part one mile high and the upper part two miles, as the electricity of the particles would be equal, those in the upper part would not have sufficient for their support, and would therefore press downwards, and those in the lower part would have more than enough to support them at that height, and would therefore press upwards, and thus press the particles in the middle of such cloud into contact and form rain, while the electricity being pressed out of the cloud, would accumulate on the surface till it could force its way to the earth or other clouds, and thus cause lightning. Violent hail-storms he attributed to the sudden equalization of the electricity of large masses of vapour floating at different heights in the air, and brought by currents and various circumstances the one over the other. The difference between the lowest mass and the top of the upper mass of clouds may amount to two or three miles. The violence of storms in such cases depends upon the density of the clouds and the height of their upper strata: as, the greater the height at which the hailstones begin to form, the greater will be the degree of cold they will acquire, and consequently the more powerfully they will not in freezing the vapour with which they come in contact during their fall; the greater also they will become by the accumulation of vapour in falling; and the greater will be the velocity with which they arrive at the earth. The lightning accompanying such storms may be caused by the lower clouds forming conductors for the electricity from the highly-charged upper clouds to the earth. The diminution of the pressure of the atmosphere previous to and during rain, he ascribed to the escape of electricity from the invisible vapour or clouds; thus causing a vacuum or rarefaction in the regions of the clouds; and the air from its elasticity rising to fill the space, decreases the pressure on the mercury. Allowing that the trade winds, land and sea breezes, &c., are caused by changes of temperature, yet he contended that the more irregular winds are owing in a much greater degree to the fall of rain and the escape of electricity from the cloud, than to any change of temperature; for as each particle of water to be buoyant must, together with its electrical coating, occupy the space of an equal weight of air, as water is 860 times heavier than air at the level of the sea, every particle of water that falls to the earth must have occupied 860 times more space when suspended in the air: therefore, if in a given time one inch of rain falls to the earth, it must, during that

time, have caused a vacuum or rarefaction in the space above to the extent of 860 inches: the vacuum would in fact be greater than this, for vapour to be buoyant must occupy a greater space according to its elevation; but as the density of the air decreases according to the elevation, the effect must be the same, *i. e.* for every inch of rain that falls the vacuum would be equal to the gradual abstraction of the whole of the air to upwards of 70 feet in height over the whole district where the rain falls; which rarefaction must be filled up during the time the rain is falling by a rush of air from the surrounding districts, although such wind may not always be felt in the same locality in which the rain falls. He supports his views by referring to the storms of wind which swept over England from the north-west and west last autumn, at which time France and other parts of the continent were deluged with rain. He exhibited the following table of heavy rains (mentioned by Prof. Forbes in his Report on Meteorology in 1840) to show that they are sufficient to account for violent storms; and had no doubt that if we had accurate accounts of the extraordinary rains which sometimes fall within the tropics, they would be found sufficient to account for the most tremendous hurricane:—

Place.	Date.	Depth of Rain in inches.	Time.	Average Vacuum per sq. mile per second.
Catkill, U.S.	July 26, 1819 ..	18 in. ..	7½ hours..	1,331,968 cub. ft.
Genoa	Oct. 25, 1822 ..	30 in. ..	24 " ..	693,733 "
Joyeuse	Oct. 9, 1827 ..	31 in. ..	22 " ..	782,027 "
Geneva	May 20, 1827 ..	6 in. ..	3 " ..	1,109,973 "
Gibraltar ..	Nov. 27, 1826 ..	33 in. ..	26 " ..	704,406 "
Naples	Nov. 22, 1826 ..	9 in. ..	37 minutes	809,980 "
Perth	Aug. 3, 1829 ..	½ in. ..	30 " ..	887,978 "

"The Progress of Tides."—The MASTER of TRINITY COLLEGE, Cambridge, delivered a report of a Committee consisting of himself and Capt. Sir J. Ross appointed at Southampton to draw up a plan for a naval expedition for completing our knowledge of the progress of the Tides.

The knowledge which we possess of the tides, looking at the connection of the phenomena over the whole surface of the ocean, is extremely imperfect at present, and not at all likely to be completed in any material degree in any finite time, by the observations which voyagers mainly directed to other objects will supply. The coasts and islands which surround or break the waters of the Pacific, are especially the seats of this ignorance. We know the time of tide near Cape Horn, but cannot trace the progress of the tide waves along the western coast of South and North America. We know the time of tide on the coasts of New Zealand, but cannot connect this fact with the rise and fall of the water on the coasts of the smaller islands in the centre of the ocean. We know the tide hour on the eastern coast of New Holland, but cannot trace the progress of the tide to the Philippines or to the coast of China—though some observations of Admiral Lütke, made a few years ago, supply a valuable addition to our knowledge on this subject. The course of the tide wave among the islands of the Indian Sea is likewise entirely unknown. Observations made by voyagers mainly guided by other purposes appear unlikely to supply this deficiency in our knowledge, for even when made with sufficient care and for several weeks at detached places, they are rarely connected with each other or with neighbouring places. It does not appear that while we are thus left to depend on chance for our tidal knowledge, we shall ever be able to know from observation whether the tide wave in the Pacific does or does not move from east to west. But a ship sent out on purpose to observe the tides could very soon ascertain a great body of facts of this kind. The observers would, of course, observe the facts of the tides in connection with each other; and would arrange their plan of operations so as to extend their lines of connection from known points to unknown. By such a mode of proceeding the co-tidal lines for every part of the Pacific and Indian Oceans might probably be drawn (omitting the minor details in the interior of archipelagos, &c) in a year, at most in two years.

The tide observations made, at the request of Dr. Whewell, in 1834, for a fortnight by the coast guard on the coasts of Great Britain and Ireland, prove how great an accession our tidal knowledge may receive from connected observations; and still more those made in June 1835, for a fortnight along the coasts of the whole of Europe and the eastern coast of the United States of North America. By means of these observations the general course of the tides in the year thus explored has been determined. If an expedition were sent for the purpose of making tide observations, it would not be at all necessary to have, as in the instances just mentioned, simultaneous observations along the whole line of sea observed. It would suffice to connect a few places by corresponding observations, in some cases for a fortnight, in others for a few days; then, to connect one of these places with others, and thus to proceed through the whole region observed. It appears by the experience of the surveys which we have referred to that the observations may be made by sailors, such as those employed on the coast guard, under proper directions. On those occasions the necessary apparatus was speedily constructed by the persons employed. It might, however, be useful also to employ, in several places, self-registering tide-gauges such as are already established in several English ports.

We conceive that the project contemplated by the Association in its recommendation is very desirable; and might best be attained by sending out a vessel which should have for the object of its voyage to make tide

observations upon such a connected system. For this purpose, the vessel ought to carry, in addition to a crew sufficient to work her, ten or fifteen men, who, by themselves (in pairs) or under the direction of petty officers, might be trusted to make tide observations for a week or a fortnight at selected points of coast. The surveying vessel ought to be provided with a launch to be employed in carrying these observers to their station, visiting them while engaged in their work, or fetching them away when their task at each place is done. From one region to another of the ocean, standard stations ought to be selected, at which tide observations should be continued for a longer time, and the observations made in each region should be compared with those at the standard station. The comparison of the observations with each other, as the survey proceeded, would point out the direction in which it was desirable to extend the survey, and the special points to be attended to. We, therefore, recommend that application be made to the Admiralty that they would appropriate to this service a suitable vessel.

Mr. ORLEBAR informed the meeting that he had, while at Bombay, conducted a regular series of observations on the progress of the tides; that similar observations had been made in other parts of India, and at Aden at the mouth of the Red Sea; and that the Geographical Society had seen the importance of these observations, and had lately turned their attention to them.

The ASTRONOMER-ROYAL inquired at what intervals the observations at Bombay were taken?

Mr. ORLEBAR replied that they were taken by a tide gauge, and were, therefore, continuous.

The ASTRONOMER-ROYAL said that frequency of taking the observations was most essential. Upon analyzing the observations he had lately superintended round the Irish coast, the extraordinary fact had been ascertained that at some places four tides took place in the day; and the continuance of the waves of these tides could be distinctly traced to a considerable distance on each side south.

Mr. ORLEBAR said that nothing had been done in the way of analysis or reduction of the Bombay observations.

Dr. WHEWELL pointed out several peculiarities of the tides in the East Indies—particularly dwelling on those at Singapore. He also drew attention to the researches of Admiral Lütke on the north coasts of America and in the Northern Ocean; and begged to ask Prof. Struve whether those were not still continued.

Prof. STRUVE replied that the researches of Lütke were still continued, particularly along the shores of the White Sea and various parts of the Northern Ocean; and he believed he was almost the only navigator who had bestowed a large portion of attention on the determination of co-tidal lines.

"On English Measures."—The ASTRONOMER ROYAL stated that it would be interesting to learn that one of the chief objects of their illustrious visitor, Professor Struve, when coming to England, was to make a comparison of the English standards of length with those of Russia.—M. STRUVE stated that one of the special commands which he had received from his royal master was to make that comparison with minute accuracy. A knowledge of the English standard was of much consequence in Russia, as the *Sagene* of that country was exactly equal to seven English feet.—Sir JOHN HERSCHEL said, that although England was at this moment without a Parliamentary standard of length, yet one would soon be completed, as the commissioner for that purpose had nearly brought his labours to a close. The present was, therefore, a peculiarly appropriate time for both countries that the comparison contemplated by Professor Struve should be instituted.—The ASTRONOMER ROYAL said that the standard now in progress under the superintendence of the commissioner was being executed with such extreme accuracy, that he felt convinced that it would not differ from what it was intended to represent beyond the minute fraction of the 100,000th part of an inch. He begged to ask M. Struve whether the relation he had stated between the English foot and Russian *Sagene* was strictly or only approximately exact?—M. STRUVE replied that it was a matter determined by law; and that hence the Russian *Sagene* had to be varied whenever the English foot was changed. That hence the comparison had to be made with rigid accuracy when Captain Kater's determinations had been concluded, as well as on other occasions besides the present.

"On some Recent and Remarkable Examples of the Protection afforded by Metallic Conductors against Heavy Strokes of Lightning."—By Sir W. S. HARRIS.

The possibility of guarding buildings and other structures against the destructive effects of lightning, has been made a great question in practical science—from the time of Franklin to the present day; and it is of considerable public importance, seeing the damage which occurs to our beautiful churches and other edifices by strokes of lightning, to bring this question completely under the dominion of induction, observation, and experiment. The general principles which Sir W. S. Harris submitted as deducible from the inquiries to which he alluded are these:—If we imagine a ship or building to consist altogether of metallic substances, it would certainly be secure from any damage by lightning; and for this simple reason, that what we call lightning is the result of the electrical agency forcing a path through resisting matter such as the air, and extricating with explosive and expansive force, both light and heat in its course. When, on the contrary, it falls upon comparatively non-resisting

bodies, such as the metals, then this form of lightning vanishes, and the discharge assumes, if the metallic body be sufficiently capacious, the form of a comparatively quiescent current. Our object should be, therefore, in defending any building or ship from lightning, to bring the general mass so far as possible into that passive or comparatively non-resisting state it would have supposing it a mass of metal. This is, in fact, the single and simple condition of such an application, without any reference whatever to assumed forces of attraction or peculiar specific powers manifested by certain bodies for the matter of lightning, and which really do not exist. This simple principle, by a careful mechanical arrangement, calculated to render it practical and applicable to all the duties which the general structure of a ship together with its masts has to perform, is now universally carried out in the navy, with the most perfect success; so that damage by lightning in the vessels so fitted has, for the last fifteen years, quite ceased. The masts are made completely conducting by capacious plates of copper, reaching from the highest points to the keel; and are tied into one general connection with all the great metallic masses employed in the construction of the hull, and united by the large bolts of copper passing through the keel and sides, with the copper expanded over the bottom and with the sea. It is quite impossible that a discharge of lightning can fall on the vessel in any place, and not be at once transmitted safely by the conductors, not under the form of lightning, but under the form of a current without explosion. Sir W. Harris then referred to some remarkable cases.

"On Ancient Sea Margins." By Mr. R. CHAMBERS.

The existence of marine detritus containing recent shells at various heights above the present sea level has long been well known. These deposits are sometimes met with at an elevation of 1,200 or 1,500 feet—and much more frequently at lower levels. They often appear in the form of ancient sea-beaches or terraces, marking periods in which the relative level of land and sea remained stationary. Indications of this kind abound on all the coasts of Great Britain, Ireland, and France, and are also seen more inland. The sea has left traces of its presence sometimes by wearing away the coast into hollows and caverns, at others by filling up hollows with sand and shingle, or forming rude platforms at the bases of cliffs. In shores of moderate inclination these effects are most conspicuous; since on coasts having a very small inclination the sea makes little impression, whilst on a bold coast no accumulation remains. The valleys of rivers also afford memorials of the former presence of the sea. Many of them were once estuaries, and still exhibit terrace banks and platforms of detritus brought down from distant mountains. The nature of the deposit marking the margin of the ancient sea varies with situation and circumstance, being arenaceous or gravelly, clayey, or alluvial. The author has examined numerous examples of these deposits on the coasts and in the valleys of Scotland and England, and measured their elevation above the sea. He finds them most constantly and well marked at certain particular levels, which he has called, for the sake of distinction, after the places where the phenomenon is most strikingly exhibited.

The first level at which indications of the former action of the sea are found is only about 11 feet above high water. The second is from 22 to 40 feet above the sea, and termed by the author the Chichester Beach. The third terrace is 64 feet high on the seaward side, rising to 80 feet inland, and called the St. Andrew's Beach, being well marked near that University. The fourth, or Kingstown Beach, is from 98 to 100 feet above the sea, and is seen only in a few places—as for example, near Inverness, and at Kingstown, near Dublin. The fifth, or Paxton Beach, from 114 to 128 feet. The sixth, or Bourland Beach, is very generally found at 168 feet above the sea. The seventh, or Paris Beach, from 180 to 186 feet. The eighth from 275 to 280 feet: and the ninth, or Versailles Beach 386 feet.

Besides these, there are at some localities indications of the sea margin at other heights, and marking stationary periods of briefer duration. One of these, at the height of 50 feet, is visible on the shores of the Firths of Tay and Forth; others occur at elevations of 113, 130, 150 feet, and near Peebles there is one at 545 or 547 feet.

The following districts were described by the author as presenting examples of a succession of sea margins at many or all of their levels:—the valleys of the Ness and Spey, the Firths of Tay and Forth, St. Andrew's, the Vale of the Esk, Preston, Liverpool, and Birkenhead, at 64 to 70 feet, and again at 128 feet; Bristol, at 280 feet; Weston-super-Mare and Brent Knoll, at 158 feet; Bath, at 186 feet; Chichester; in the Isle of Wight, Osborne House stands on the Paris Beach at 181 feet; Exeter; Torbay; London, where Mary-le-bone represents the St. Andrew's Beach, at 65 feet, and Deptford at 64 feet; Paris, along the line of the barriers, at 186 to 196 feet; Rouen exhibits the St. Andrew's Beach at 69 feet, and the Paxton Beach at 126 feet, whilst the table land around is 540 feet; the Pont de l'Arde, a broad terrace at 186 feet, and Dublin, a succession of sea margins at 60, 107, 139, 171, 272, and 280 feet.

The author considers it probable that this uniformity in the level of the successive margins of the ancient sea will be found to extend also to Norway and perhaps to North America. On the shores of the Alten Fjord are a succession of terraces, considered by Bravais to form part of only a single line of sea level, one extremity of which has remained stationary, whilst the other has been elevated several hundred feet. Mr. Chambers, however, states that the intermediate elevations correspond in level with his series of terraces, and believes they were formed at the same successive periods. Along the shores of the great Ameri-

can Lakes there are also terraces at various elevations, corresponding with the more remarkable elevated beaches in Britain. In conclusion, the author observes that these phenomena cannot be accounted for by supposing a number of distinct and local disturbances; but imply an equable elevation of the land (or subsidence of the sea) simultaneously over large areas: and he points to the plains of South America described by Mr. Darwin in proof of the occurrence of such uniform elevations.

Remarks.—Mr. J. PHILLIPS remarked that those who had accepted Mr. Darwin's or Mr. Hopkins's views of the nature and mode of the force by which tracts of land were elevated would believe that the surface of an elevated tract must incline from an axis, or point of greatest elevation. He considered many of Mr. Chambers's raised beaches, such as those of Brent Knoll and the Gloucestershire valleys, had in reality been produced by the removal of softer beds of horizontal rock, and that as many terraces would be found as there were alternations of hard and soft materials.

Prof. SEDGWICK contended that it was extremely improbable that the elevation of the land had taken place so uniformly all over England as described by Mr. Chambers; much less, that France and Norway and America would be raised the same number of feet at many successive periods. The elevation of the bed of the sea and its conversion into dry land had taken place repeatedly from the earliest to the latest geological periods; and strata were found in every kind of position, inclined, vertical and contorted, and seldom horizontal over any wide space.

Sir H. DE LA BECHE observed that in pursuing this inquiry the author should be careful to ascertain that the terraces were really raised beaches, formed in the ordinary way by the action of breakers on a coast. At Bath, there were certainly no indications whatever of the sea at various levels on the hills.

Prof. LYELL described the elevated beach-lines around the American lakes as being sometimes in the form of hills of sand and sometimes of low cliffs. Allowing for these changes in character, they might, perhaps, be traced for hundreds of miles, and had been seen on the opposite shores of the lakes. With respect to Norway and Sweden, where raised beaches were numerous and well marked, observation had shown that whilst the northern provinces were still rising the southern were actually subsiding.

Prof. J. FORBES stated that external form was not sufficient to determine the existence of an elevated sea margin. All instances should be excluded where there was not an actual section to show the nature of the terrace or deposit. Much difficulty would also be experienced in determining the mean level of a well-defined sea beach. The limit of doubt could not be within six feet above or below the line chosen; and as in Mr. Chambers's sections there were nine sea beaches, eight of them under the height of 280 feet, and three intercalary beaches besides, there was only an interval of about twenty-five feet between each. It became physically impossible to identify distant beaches where the levels were so ill-defined and the beaches themselves so numerous. If the intervals had been very irregular, the comparison of one series with another would have been much more satisfactory. The terraces on the banks of the Alten Fiord were found at heights decreasing in such regular progression that he was convinced they were only portions of one terrace sloping gradually away.

Mr. DARWIN referred to the prairies of North America and the great plains of Patagonia and the Pampas of South America in support of Mr. Chambers's view of the occasional uniform elevation of large tracts of land. The raised beaches in the Andes occurred at irregular intervals to a height exceeding 500 feet, and maintained a uniform level for great distances.

Mr. CHAMBERS, in reply, stated that he had necessarily omitted a great portion of the details in his paper, which would have explained or supported the particular cases, and had thrown out his general views to invite discussion and further inquiry.

PROCEEDINGS OF SCIENTIFIC SOCIETIES.

INSTITUTION OF CIVIL ENGINEERS.

June 29.—The President in the Chair.

This was the last meeting of the session, and several papers were read in abstract because there was not time for giving them in extenso.

The first was "*On the Advantages and Economy of maintaining a high degree of Cleanliness in Roads and Streets; with an account of the Construction and Operation of the Street-sweeping Machine.*" By Mr. J. WHITWORTH.

It treated of the general advantages of street cleanliness, the comfort of the pedestrian, the avoidance of impurity to the air from the decomposition of dirt on the pavement; less dirt and dust being carried into the houses, a saving in the cost of maintenance of roadways, and a diminution of the draught of carriages. The annoyances of the common method of cleansing were then detailed—with the importance of employing plenty of water in the cleansing of streets, to liquify the mud, to cause the dirt to swell and rise from between the stones, to cool and purify the air during hot weather, and to prevent the dust from being driven into the dwellings. It then showed how much economy there resulted from having force enough to

cleanse the streets thoroughly and simultaneously in wet weather, particularly by Whitworth's sweeping machine, which is a cart drawn by one horse and managed by one man; it has on one of the wheels a toothed wheel working into a pinion, which gives motion to a drum over and around which passes two endless chains passing also round another drum at the lower extremity of a light frame suspended at the tail of the machine, over an inclined plane depending from the drum frame; these endless chains carry a series of broad brushes formed of an Indian rush of peculiarly elastic and durable nature; they travel at a velocity depending upon the speed of the horse, and impinging upon the ground with a force which is regulated by a coiled spiral spring, carrying the dirt up the inclined plane into the cart, whence it is emptied when the receptacle is full.

The next paper read, was "*An account of the sea defences of Romney Marsh, commonly known by the name of Dymchurch Wall, and the probable origin of the Marsh itself, or the manner in which it was reclaimed from the Sea.*" By Mr. JAMES ELLIOT, Jun., the resident engineer.

Romney Marsh, properly so called, forms a triangle, the base of which would be a line drawn from Romney to Appledore, and the apex at Hythe, and comprises about 24,000 acres. It is probable, that this marsh was caused in the first instance by the formation of a natural barrier of shingle, nearly where Dymchurch Wall now stands, by which the sea was excluded, and that the first artificial works were executed by the Romans, when they held possession of the country. They consisted of the erection of cross walls running from the natural barrier (the "Full") to the hills, at the base of which the ancient river Limene ran. The chief of these (the Rhee Wall), ran nearly in a straight line from Romney to Appledore, and it was at that spot where probably the main work was performed.

Upon the supply of shingle from the west being cut off by the extraordinary accumulation at Dungeness Point, the natural barrier at Dymchurch gradually became weakened, and it was necessary to take some steps to prevent its total destruction; the first measure adopted was the erection of an inland wall at some little distance, at the back of the "Full," and afterwards, the construction of large stone groins on this point or sea-side, at right angles to the line of coast, in order to increase the deposit of shingle. However, as the supply of shingle gradually decreased, on account of the constant movement to the eastward, and as all that escaped in that direction was permanently lost, these means were found insufficient, and a system of "arming," with brushwood and timber-piling was adopted. This was found to answer the purpose for a considerable period, but it also, in the course of time, gradually became insufficient; and it was found necessary, at length, after numerous experiments, to adopt a stone facing with an average slope of about eight to one, up to high-water mark, gradually increasing in steepness from that point, and terminating in a curve of seven feet radius. The stones, which were laid in a bed of concrete, where they were most affected by the waves, were of different sizes, averaging from eighteen to six inches in depth, the largest of them being in the middle, where the greatest wear and tear took place, and at which place rows of sheet piling were also driven for additional security.

This plan was adopted by the author after mature deliberation on the reports of Mr. Rennie and Mr. Walker, and a very careful examination of the locality. Part of the wall has now been standing for ten years, and has required a very trifling amount of repair, while the annual expense has been reduced from 10,000*l.* to 4,000*l.*, with every prospect of a still further reduction being effected, as upwards of two-thirds of the work are now permanently completed.

The last paper was, "*On Ocean Steam Navigation,*" by Captain HENDERSON, calling attention to the fact, that in this great maritime nation, naval architecture was neglected as a science, as was proved by the experimental squadrons and some of the ordinary steam vessels lately built. Neither the public nor science had derived any advantage from these costly experiments, owing to the absence of any information, in a systematic form, that correctly described the relative size, capacity, resistance, power, or speed of steam-ships; the present tonnage and nominal horse power, for all purposes of analogy, being quite fallacious.

The meeting was then adjourned until the second Tuesday in January, 1848.

ROYAL INSTITUTE OF BRITISH ARCHITECTS.

June 28.—C. FOWLER, Esq., V.P., in the Chair.

Dr. BROMET, F.S.A., exhibited a Drawing of a Templars' Church of the twelfth century, at Metz, having an octagonal nave with a pyramidal roof, and a semicircular apsis with a semi-conical roof;—also a Drawing of a Twelfth Century Church at Mathieu, near Caen, showing an arch between the nave and choir of elliptical form, and ornamented with three rows of counterset chevrons.

A Letter was read from SYDNEY SMIRKE, Fellow, on some peculiarities in the Architecture represented on the Bas-reliefs recently brought from Nimroud, and now in the British Museum.

A paper was read:—"A Sketch of the professional life of George Dance, Architect, R.A.," by SAMUEL ANGELL, V.P.

The Premiums in Books awarded in the Students' Class at the previous General Meeting were presented as follows:—

To Mr. W. BOUTCHER, for the best Series of Sketches of Designs from Subjects given monthly by the Council,—a Copy of Chambers' Treatise

on Civil Architecture, by Gwilt; and for the best Notes of Papers read at the Meetings during the Session,—a Copy of Hope's Historical Essay on Architecture.

To Mr. S. J. NICHOLL, for his Notes of Papers read at the Meetings during the Session,—a Copy of Milizia's Lives of the Architects, translated by Mrs. Cresy.

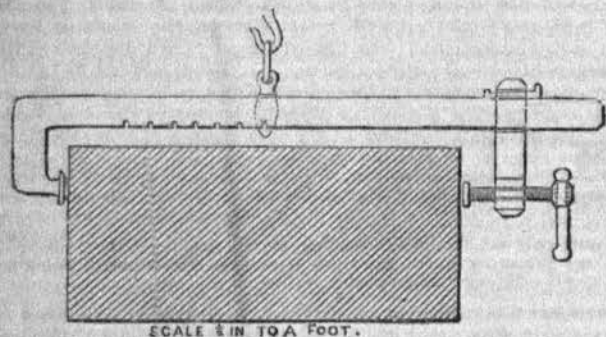
A curious Model of a Chinese Chemist's House and Shop were exhibited to the Meeting, and the several arrangements explained by Professor DONALDSON.

In announcing this as the closing Meeting of the Session, the Chairman adverted to the general proceedings of the Institute during the year, and took occasion to express the regret generally felt at the recent decease of their highly esteemed Honorary Member, Mr. J. B. Papworth.

It has been arranged to set apart an evening, early in the ensuing Session, for the discussion of the subject propounded in the paper read by Mr. CHANTRELL, at the meeting of the 14th of June, "*On the Geometric System applied by the Mediæval Architects to the proportions of their Ecclesiastical Structures.*" by which time it is hoped that those Members who feel particularly interested in the subject will be prepared to offer their opinions thereon.

A STONE-LIFTER.

Being engaged in the construction of bridges, &c., on the Great Grimsby and Sheffield Junction Railway, and the engineers objecting to lewis-holes in the face of the coping, Mr. Joshua Oliver, clerk of the works, suggested



a plan to obviate the difficulty. The annexed sketch is a representation of the apparatus, which is nothing more than a bar of iron, $3\frac{1}{2}$ inches wide and $\frac{1}{2}$ an inch thick, with a sliding piece and screw; but should it be used for rough stones, the screw may be dispensed with by adding a key to the top of the sliding piece, as shown by the dotted lines.—*Builder.*

SULPHURIC ACID.

At the College of Chemistry, June 23, a lecture "*On the manufacture, properties, and uses of Sulphuric Acid,*" was delivered by Mr. HENRY M. NOAD.

After alluding to the great importance of chemistry and its bearings on almost every branch of social industry, the lecturer observed that it may even be classed among the principal elements of civilisation. In illustration of which, he adverted to the influence exerted by sulphuric acid on the manufacture of soap—an article, the consumption of which is not subject to the caprices of taste or fashion, but absolutely essential to cleanliness and comfort. From the year 1829 to 1834 the average importation of barilla into this country amounted to 12,600 tons. Now, however, this ash is scarcely to be met with in the market;—nearly the whole of the soda consumed in this country in the manufacture of soap and for other purposes being obtained from common salt through the agency of sulphuric acid; and the united quantity of soda ash and soda crystals annually manufactured is calculated to exceed seven times the largest importation of barilla ever made in one year. This increased consumption of soda is due to the repeal of the salt duty, and to the improvements that have been effected in the manufacture of sulphuric acid.

Mr. Noad proceeded to review the sources and properties of sulphur; and after showing how extensively this elementary substance is diffused throughout the globe and in all the kingdom of nature, he remarked on the imprudent policy of Sicily in granting to a French company, in 1838, a monopoly for the purchase and sale of sulphur—a course which, had it been persevered in, would, probably, ere this have entirely, or to a great extent, deprived Sicily of her lucrative article of commerce. During the time the monopoly lasted (only two years) no less than fifteen different patents were taken out for methods of obtaining back the sulphuric acid used in the manufacture of soda. Hundreds of thousands of pounds

weight of sulphuric acid were prepared from pyrites; and a process was indicated for decomposing gypsum. Even at the present time large quantities of sulphuric acid continue to be made from pyrites; and in 1842 the importation of sulphur from Sicily was not one-third of the amount imported in 1836. The lecturer described the various compounds of sulphur with oxygen; illustrating experimentally the properties of sulphuric acid. He gave a detailed account of the present method of preparing sulphuric acid on the large scale;—imitating it on the lecture table by causing two streams of sulphurous acid and nitric oxide gases to come into contact, together with steam and common air, into a large glass globe; and he explained the theoretical nature of the reactions which took place by means of diagrams. The leaden chambers employed in some manufactories were stated to be of immense size—upwards of 180 feet long, having a capacity of 35,000 cubic feet, and being capable of preparing ten tons of acid weekly. The great saving effected by the modern improvement of substituting vessels of platinum for those of glass for the final concentration of the acid, notwithstanding the enormous price of the former, is manifested by the fall in the price of sulphuric acid from 4d. to 1½d. per pound. The lecturer performed a series of experiments in illustration of the valuable properties of sulphuric acid. He adverted to its great use as an elegant and economical means of refining silver—and to its introduction into agriculture as a solvent for bones, by which phosphate of lime is not only brought into a liquid state—and thus more intimately diffused through the soil—but a portion of phosphoric acid is likewise set free to combine with lime or other basic matters in the soil. The lecture was concluded by observations as to the manner in which the sulphates act as manures—viz., by furnishing the necessary supply of sulphur to those parts of plants in which this element is found—and of which it appears to be an essential constituent—viz. the gluten and albumen of the several varieties of grain, and the legumin of those plants which are called *leguminous*.

WARMING AND VENTILATION OF THE NEW HOUSE OF PEERS.

We have been requested to give an account of the system adopted by Mr. Barry, for the warming and ventilating the New House of Peers. We cannot do better than give Professor Faraday's account, read at the Royal Institution:—

Mr. Barry's plan of warming and ventilating the three rooms to which he has applied it (i. e., the royal ante-chamber, the house of peers, and the public lobby), consists, first, in causing a current of air, of regulated temperature, to pass beneath the impervious floor of these apartments, and afterwards to rise to a chamber at the top of the building, from whence it is diffused in great abundance, but imperceptibly, throughout the three apartments; and secondly, in drawing off the vitiated air and discharging it with great rapidity into the atmosphere. To accomplish these objects, Mr. Barry has achieved expedients for,

1. Warming the building through an impervious floor, as in the case of a Roman bath. 2. Effecting a system of currents. 3. Providing means of causing ten thousand cubic feet of air per minute to proceed in a prescribed course, and with regulated velocity.

The warming is effected by a steam-cockle, supplied from one of Lord Dundonald's boilers; it is traversed by a quantity of air-tubes firmly fastened into it. The air which passes through the tubes is the source of warmth. This apparatus, with its furnace, is placed beneath the public lobby; and the current of warm air passes beneath its impervious floor, then beneath that of the House of Peers, and lastly, beneath the floor of the royal ante-chamber beyond. With warmth, the air acquires a certain degree of motive power in the rising parts of the passages, which carries it onwards till it reaches the reservoir chambers at the summit of the building; from thence it is made to pass down into the apartments by their walls, and so distributed, without draught, to be breathed by the inmates of those rooms. This gradual diffusion of the air is accomplished by a system of currents. It is caused by subjecting the air to inequalities of temperature. Descending by the walls of the building, it is cooled by windows, &c., and thus its velocity downwards is increased. Arriving at the level, at which it is at once heated and deteriorated by respiration, combustion, &c., the air again rises in the centre of the room, and passes through the ceiling into a foul-air chamber, which is in connection with a chimney. Through this chimney the air is driven by the third expedient adopted by Mr. Barry, viz, draught of the flue,—and a peculiar motive power furnished by Bell's steam-jet [see *Journal*, last month, page 230.] a source of force which has so many philosophical considerations connected with it, that Mr. Faraday expressed his intention of making it the subject of a future day's discourse. He therefore limited himself at present, to the simple statement that steam produced under 32lb. pressure on the square inch, will set in motion 217 times its bulk of air.

In the course of his communication, Mr. Faraday described the arrangements made by Mr. Barry to clear the air, and to regulate its velocity, so as to prevent the possibility of draughts coming on any inmates of the apartments. He showed how the steam-cockle, employed to give warmth in winter, might, by filling it with water from the Artesian well, become a source of coolness in summer. These, and many other important arrangements, were illustrated by sections in relief.

The advantages expected from this mode of ventilation, are, 1. The prevention of local draughts. 2. The prevention of the stains and disfigurements resulting from such draughts. 3. The avoidance of all movement and dispersion of dirt and dust of the house by currents occasioned in it, which currents, if existing, would tend to render the air impure. 4. The avoidance of all sudden change of temperature. Finally, it was noticed that all parts of the house were fire-proof. Mr. Faraday then took occasion to remark that this scheme of ventilation was under a disadvantage in the present case, as it had to be adapted to buildings which were not planned with reference to it.

DREDGE'S SUSPENSION BRIDGES IN INDIA.

Major Goodwyn has addressed the following letter to the Editor of the *Englishman* (Published in India in reply to Mr. Dredge's remarks):—"Sir, Adverting to a statement which lately appeared in your paper, and which, with certain comments, has found its way into the *Star* and *Madras Spectator*, relative to the failure of an iron bridge on the taper chain principle, manufactured by the patentee, Mr. Dredge, sent out by him, and put up at Jessore, I feel myself bound to offer a few words, as the measures of the Government have been misrepresented, and the facts of the case considerably distorted. The span, width of roadway, height of point of suspension, being necessary data to furnish Mr. Dredge with, these dimensions, and these alone, as connected with the required strength of the iron-work, were sent to him, and he was further particularly instructed to form the eyes of his links in a peculiar way (which, however, he did not observe). Mr. Dredge, as I before said, required the above data on which to calculate the strength of his ironwork, and the angles at which his rods were to be placed. Not one of these details was sent from here, nor was it likely he would have adhered to them if they had been, for it was naturally his interest to protect his patent by every care he could bestow, and it is sufficiently evident he did attempt it when he made the longitudinal beams 25 per cent. above what he was in the habit of doing, not 'as the drawings warranted,' for no drawing went from this country, saving a tracing of the masonry design, and section of the river, with sundry queries relative to the retention of the chains in the ground. To prove that the drawings of the iron-work came out from, instead of going to Mr. Dredge, I send you his sheet of plans, which were accompanied by most elaborate injunctions, all of which were fulfilled, and the bridge was most correctly put up. Yet the bridge fell, though it might have been standing now if it had only been subjected to the ordinary traffic of the country, and guarded from the unusual crowd to which it was exposed.

"I have said already more than I intended; suffice it to add, that once a sincere admirer of the system, I have had experience enough to discover its defects; full explanations and refutations of Mr. Dredge's statement have been sent to the scientific journals in England, and will appear in due course, as will also an elaborate treatise on the system in all its bearings: let the discriminating public wait a little, and hear both sides of the question."

NOTES OF THE MONTH.

Centre Punch.—It is customary, in moving the "centres" of a piece of iron intended to be turned, to drive a centre punch into the holes previously made; first, at an angle, in order to force the metal over to the side required, and then, to drive it in, perpendicularly, in order to give the hole the proper shape for the lathe centres. This is frequently repeated, until the hole is mutilated, or driven so deep as to be objectionable, and is absolutely barbarous on a nice piece of work. There are other modes of moving the centres of accurate work, such as the scraper and centreing drill, but this is the mode generally adopted on account of convenience, and has done injury to much fine machinery. The new plan adopted for this purpose, which I saw in a small shop at Massachusetts, appears to me to be equally convenient with the ordinary centre-punch, while it is quite as perfect and unobjectionable as any of the more tedious modes. This tool is formed by making the conical point of a centre-punch on an angle with its shaft. It will be readily seen that by using this punch, the hole will be more easily moved laterally, that its uniform conical shape will be preserved perpendicular, and that the distance of moving it may be accurately managed by the blow of the hammer upon the punch.—P. B. TYLER, *New Orleans*.

Skimming Ladles for Pouring Cast Iron.—In a foundry at Connecticut, there is a mode of skimming small ladles for pouring cast iron, which is found to be very useful. It consists in riveting a small bar of iron across the top of the ladle, just at the back of the mouth, and covering it with clay, the same as at the bottom of the ladle, to prevent its cooling the melted iron. The bar should extend far enough below the top of the ladle to commence skimming from the first, and near enough to the mouth to

continue until all is poured. I saw some ten or fifteen persons pouring with these ladles, while not one was required to skim, and I was told that no objection was found to it in any respect.—*Ibid*.

The most Extensive Manual Structure is, undoubtedly, the great Chinese wall. It is 24 feet high and 10 feet wide, and reaches to the extent of from 2,000 to 2,400 miles, over mountains, precipices, and rivers, up to the sea on one side, and the inaccessible mountains of Thibet on the other. The Chinese truly call it one of their wonders of the world—as the stone used for its construction, if placed one beside the other, would suffice to encompass the whole circumference of the globe. The entire history of this construction is wrapt in similar obscurity with that of the Pyramids of Egypt. Chinese documents ascribe to the founders of the empire the benefit of a vast system of drainage and exsiccation of the land, after which came the great world-dearth of seven years, &c.

Malleable Glass.—Prof. Schönbein has discovered a substitute for glass. It consists of pulp of common paper, made transparent, by causing it to undergo a certain transformation, which the Professor calls *catalytic*. With this paper, made waterproof, is manufactured perfectly transparent window-panes, vases, and bottles, which will not easily break.

Dover Landing Pier.—The lords of the Admiralty have at length been pleased to give their sanction to the erection of a landing pier in Dover Bay, according to the plans prepared by Messrs. Birch, and submitted to them by the Town of Dover. The commissioners of the harbour also have given their assurance that the measure shall meet with every assistance from them. A company is, therefore, now forming for the purpose of carrying out this desirable work, and it is determined to use every endeavour to get the erection completed during the present season. The pier will extend 800 feet into the sea, and at its extremity will be a lozenge construction of four sides, affording to steamers not only unusual accommodation in coming alongside, but the certainty of a good lee in stormy weather. The advantages of the pier will be greatly felt by the mail establishments of the British and foreign governments, who have expressed their willingness to entertain the question of an annual grant for its use,—as well as by the continental steamers, who will thus be enabled to effect a landing of passengers at low tide, which is a question of great importance to Dover, and enables it to maintain its high position as a point of embarkation to the continent.

"*The Express*" steam vessel, built for the South Western Steam Navigation Company for the Southampton and Havre station, by Messrs. Ditchburn and Mare, and fitted with engines by Messrs. Maudslays and Field, made an experimental trip on the Thames on the 4th ult. It is stated she performed the distance from the Nore lights to Blackwall, a distance of 47 miles, in 2 hours and 8 minutes. (Qy. with tide.)

Brighton and Continental Steam Packet Company.—The two boats built for this company have been running from Shoreham to Havre since the 1st ult., and have answered the directors' expectations in every respect. One of the boats ran the distance (84 nautical miles) in 6½ hours. When the Dieppe railway is open, Dieppe will be the port instead of Havre. When the works at Newhaven are completed, that port will be the place of departure instead of Shoreham, by which a saving of ½ or ¾ of an hour will be effected, and in fine weather the boats will frequently go over in about four hours.

Railway Opened.—On the 20th ult., a further extension of the South Devon railway, from Newton to Totness, a distance of 8½ miles, was opened.

Short Time for Building Operatives.—We are happy to state that a system of leaving off work on Saturdays at 4 o'clock is about to be carried out: it has, we understand, been already adopted among the carpenters and joiners of London, in the shops of Mr. Thomas Cubitt, Mr. William Cubitt, Mr. Baker, Mr. Piper, Mr. Jackson, Mr. Lee, Mr. Seth Smith, &c.

Prevention of Iron from Rusting.—The Royal College of Chemistry offers a premium of £1,000 for the discovery of a method of rendering iron, when used for ordinary purposes, as little liable to rust as copper.

Printing Types.—M. Coblentz, a topographic printer in France, states that type may be hardened by galvanism.

Grindstones.—M. Jules Pageot, of Hérimoncourt, has adopted a plan to preserve his workmen from the ill effects presented by the use of grindstones in his factory, by applying a ventilator to carry off the siliceous dust before it can reach the mouth or nostrils.

Conversion of Diamonds into Coke.—At the meeting of the British Association, Dr. Faraday exhibited some diamonds, which he had received from M. Dumas, which had, by the action of intense heat, been converted into coke. In one case, the heat of the flame of oxide of carbon and oxygen had been used—in another the oxy-hydrogen flame—and in the third the galvanic arc of flame from a Bunsen battery of 100 pairs. In the last case, the diamond was perfectly converted into a piece of coke—and in the others the fusion and carbonaceous formation were evident. Specimens in which the character of graphite was taken by the diamond, were also shown. The electrical character of these diamonds were stated also to have been changed—the diamond being an insulator, while coke is a conductor.

Iron for Girder Bridges.—Mr. Murray, a valuable contributor to the *Mining Journal*, suggests that iron girders and similar supports ought never to be made of cast iron, but of wrought iron, and composed of plate; twisted previously into a rope, and finally moulded into the required forms

a trusty "Toledo," or a Damascus blade, being so worked and moulded, will bend, indeed, but never break.

The City of Mexico.—Conspicuous among the beauty and magnificence of the grand city of Mexico is the Main Plaza. It covers an area of twelve acres, paved with marble, forming one of the most beautiful promenades in the world. On every side of this great square magnificent and costly public buildings are situated. On one side is seen the spacious cathedral, which extends the whole length of the square, and the government palace extends the whole length of another side. The cathedral is erected on the site of the great idol temple of the Aztecs, and the government palace on the ground of the palace of the great Montezuma. The amount of wealth in the cathedral is incredible. The altar is covered with plates of massive silver and beautified with ornaments of massive gold. The balustrade enclosing the altar extends a length of 100 feet; and is made of a massive composition of gold, silver, and copper, the value of which is exceedingly great. Statues, vases, and candelsticks, of gigantic size, are scattered through the building; and when we know that these, too, are made from the precious metals, we can form an idea of the immense wealth of this cathedral. There are about 80 churches in addition to the cathedral, richly ornamented with gold, silver, and precious stones; and it is supposed that the wealth which is exhibited in this manner is as nothing to the immense treasures that are kept in concealment by the priests. The city of Mexico can also boast of a splendid theatre or opera-house, which was erected at an immense cost, and is capable of seating 10,000 persons comfortably. On the western side of the city is another square of 45 acres, with a fountain in the centre. It is laid out into pleasant walks, and much frequented in the evening as a promenade. The city of Mexico, like the city of New York, has its fashionable drive—its Third Avenue. We must, however, acknowledge that our Third Avenue cannot be compared to it for beauty and extent. Some idea of its extent may be formed from the fact that it is one mile wide; on which the most splendid carriages, in innumerable numbers, may be seen every evening. It is not unusual to see 7,000 or 8,000 horsemen and 2,000 carriages on it at the same time.—*New York Herald*.

Improved Locomotive Engine.—For some time past considerable attention has been excited among parties connected with locomotive transit by the performance of an engine built upon a new principle by Mr. Crampton, civil engineer [see *Journal*, p. 153], and upon which very extensive experiments have lately been made on the London and North-Western railway. The engine in question which has been for a few weeks taking the express, mail, and ordinary trains on that line, and performing its work in such a manner as to effect a saving of from 20 to 50 minutes in a through distance of 50 or 60 miles, was tried last week without a train, for the purpose of testing its rate of speed: when it was found that with Capt. Coddington, inspector-general of railways, Capt. Simmonds, assistant-inspector, and the patentee, Mr. Crampton, on the engine, it attained the extraordinary speed of 75 miles per hour, on a level, immediately after surmounting a gradient; and that at this rate there was a total absence of all vibration, and a steadiness of movement perfectly surprising. These great advantages are effected in Mr. Crampton's engine by the centre of gravity being brought down to its lowest possible point; the boiler, in fact, being in this machine, within 2 feet 9 inches of the rails, whilst in engines of the old construction it ran, at the very least, 5 inches above their level. The peculiarities of this engine consist in the driving-wheels being placed at the foot-plate end of the boiler; by which means the boiler itself can be brought down close to the supporting axles of the engine—and, from the peculiarity of form before mentioned, any size of driving-wheel may be used without interfering with the position of the boiler, so that longer boilers can be used if necessary. Another advantage secured by this method of building engines is, that no part of the engine overhangs the wheels, inasmuch as the fire-box is extended under the boiler and driving axle—by which also the distance between the extreme wheels is reduced 3 feet. The engine in question, the *Namur*, has only 13 feet between them, whilst in ordinary engines the same amount of power would require 16 feet.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND, FROM JUNE 26, TO JULY 19, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

Robert Wilson, of Low Moor Iron Works, Bradley, Yorkshire, engineer, for "Improvements in machinery and the arrangements thereof for forging, stamping, punching, cutting, and pressing metals and other substances."—Sealed June 26.

Evel Correll Hill, of New York, U.S., professor of music, for "a mode or modes of producing musical sounds."—June 28.

William Edward Newton, of Chancery-lane, civil engineer, for "certain improvements in manufacturing wheels." (A communication.)—June 28.

Henry Horiblower, of Daigleish-place, Commercial-road, Middlesex, engineer, for "certain improvements in obtaining motive power."—June 28.

Frederick Chaplin, of Blahops Stortford, Hertfordshire, tanner, for "Improvements in card cases and retaining or fastening papers, deeds, and fabrics."—June 28.

Paul Gilbert Preller, of Rue de Rivoli, Paris, gentleman, for "Improvements in the manufacture of dry sulphuric acid, and in the manufacture of smoking or Nordhausen sulphuric acid." (A communication.)—June 29.

Joseph Browne Wilke, Esq., of Chesterfield Park, in the county of Essex, for "Improvements in the manufacture of oil from certain nuts, from which oil has not been before manufactured, and producing a vegetable substance, and the application thereof for the purpose of affording light and other uses."—July 3.

Eliza Tonge, in the county of Lincoln, for "Improvements in ornamenting glass."—July 3.

Robert Weare, of Argyle-street, Birkenhead, in the county of Chester, watch and clock maker, for "Improvements in clocks or time-keepers."—July 3.

Alexander Mitchell, of Brickfields, in the parish of Ballymacarrell, Ireland, civil engineer, of an extension of letters patent granted to him by His late Majesty King William the Fourth, dated the 4th day of July, in the 4th year of his reign, for the term of fourteen years, from the 4th of July, 1847, for his invention of a dock of improved construction to facilitate the repairing, building, or retaining of ships and other floating vessels, and that certain parts employed in the construction of the said dock are also applicable to other purposes."—July 3.

George Alexander Miller, of Piccadilly, in the county of Middlesex, for "Improvements in lamps."—July 3.

George Augustus Huddart, Esq., of Brynter, in the county of Caernarvon, for "certain improved apparatus for the cultivation of land."—July 3.

John Hunt, of Birmingham, brass-founder, for "a certain improvement or certain improvements in effecting the combustion of gas, oil, camphine, and other substances which are or may be burned for the production of light."—July 3.

Jeremiah Brown, of Ringswinford, in the county of Stafford, roll turner, for "certain improvements in rolls and machinery used in the manufacture of iron; also in rolls and machinery for shaping a fashioning iron for various purposes."—July 3.

John Ray, of Albion-terrace, Commercial-road, East, for "Improvements in constructing or fitting the interior parts of ships or other vessels, warehouses and other depots, for the purpose of facilitating the delivering or removing from ships, vessels, warehouses, and other depots, of the cargoes or contents thereof."—July 3.

William Edwards Stalte, of Lombard-street, gentleman, for "certain improvements in lighting, and in the apparatus or apparatuses connected therewith."—July 3.

Theodore Claeys, of Ostend, in the Kingdom of Belgium, and Louis François Strand, gentleman, of the same place, for "Improvements in the manufacture of various articles from cork."—July 3.

John Carr, of Blackburn, in the county of Lancaster, for "certain improvements in looms for weaving."—July 3.

George Winslow, of Boston, in the State of Massachusetts and United States of America, merchant, for "Improvements in machinery for manufacturing files and rasps." (A communication.)—July 3.

Edmund Wheeler, of Basingstoke, in the county of Hampshire, ironmonger, for "improvements in valves for steam and other engines." (A communication.)—July 3.

John Harvey, sadler, of Holbeck, Leeds, Scotch iron merchant, for "Improvements in constructing bridges, aqueducts, and similar structures."—July 7.

Samuel Stokes, of Monkwell-street, carpenter, for "an improved machine for tracing or engraving from solid bodies, or subjects in relief."—July 10.

Robert William Slevier, of Henrietta-street, Cavendish-square, Middlesex, gentleman, for "an improved material or materials for purifying or decolorizing bodies, which material or materials may also be employed as manure and pigments and for other like purposes."—July 12.

William Edward Newton, of 66, Chancery-lane, civil engineer, for "certain improvements in the manufacture of screws." (A communication.)—July 12.

William Langley Beale, of Whitstable, in the county of Kent, smith, for "Improvements in the construction of anchors."—July 13.

Alfred Vincent Newton, of 66, Chancery-lane, Middlesex, mechanical draughtsman, for "certain improvements applicable to locomotive engines and carriages employed on railways." (A communication.)—July 13.

William Hensman, of Woburn, in the county of Bedford, for "certain improvements in thrashing machines."—July 17.

Pierre Armand Lecomte de Fontainebleau, of 4, South-street, Finsbury, for "certain improvements in machinery, for preparing cotton and other fibrous substances."—July 17.

Henry Bessemer, of Baxter-Louse, Old St. Pancras-road, Middlesex, engineer, for "Improvements in the manufacture of plates, sheets, or panes of glass."—July 17.

William S. Henson, of the city of London, for "certain improvements in the construction of razors for shaving."—July 17.

Robert William Slevier, of Henrietta-street, Cavendish-square, Middlesex, gentleman, for "Improvements in stamping, marking, cutting, embossing, or printing."—July 17.

John Sykes, and Adam Ogden, both of Huddersfield, in the county of York, for "Improvements in machinery for cleaning wool, cotton, and similar fibrous substances, from burs, motes, and other extraneous matters."—July 17.

James Whitley, of Botany, in the township of Morton, in the parish of Bingley, Yorkshire, for "certain improvements in the mode of washing, scouring, and drying of wool, alpaca, mohair, cotton, and other fibrous substances."—July 19.

Edward Light, of Esther-terrace, Bermondsey, master mariner, for "Improvements in apparatus for supporting or buoying up persons, boats, and other bodies when in the water."—July 19.

Joseph Tall, of Brixton, Surrey, builder, for "Improvements in apparatus for setting saws."—July 19.

Edward Slaughter, of Avon-side Iron Works, Bristol, engineer, for "Improvements in locomotive engines."—July 19.

Anthony Bernard Von Rathen, of Putney, Surrey, civil engineer, for "certain universal wheels or improved direct rotary engines, to be worked by steam, air, or any other elastic power."—July 19.

Joseph Jean Baranowski, of 8, Rue Neuve Clitry, in the city of Paris, gentleman, for "a ready-reckoning machine."—July 19.

BUCKINGHAM PALACE.

(With an Engraving, Plate XIV.)

Although we exhibit the Park front of the new range of building which is being added to the Palace, we are unable to speak as to more than its exterior, the designs presented to Parliament being unaccompanied by any description or any explanatory Report by the architect himself, notwithstanding that something of the kind, in addition to drawings, might properly enough have been "presented to both Houses of Parliament by command of her Majesty." We therefore, not being so intuitively sagacious in matters of architecture as it would seem, the two "Houses" are, are greatly at a loss to understand a variety of particulars that ought to be taken into consideration, for we do not get even so much as a single plan to make us acquainted with the general interior arrangements, and to enable us to judge how far Mr. Blore has been controlled by positive exigencies of accommodation, to the injury of external character,—which latter, if the truth may be spoken, is but ordinary in quality and commonplace in regard to composition. Had it been for what is called a "Terrace," or the side of a square, or any similar range of houses combined into a general architectural façade, the elevation might deserve the epithet "palatial," whereas being for the principal public front of *The Palace*, it partakes by far too much of "the dwelling-house" physiognomy, undoubtedly of a superior kind. Besides being divided into five markedly distinct portions, that have the look of being so many separate residences, each with its own entrance, the façade is in one respect, if no other, greatly less dignified than some of our club-houses, the latter not having—at least, not showing externally—any chamber-floor, or one of lodging-rooms, over the principal floor; whereas here, there not only is such floor, but it is made quite as important as the other, so that except what distinction it receives from its window-dressings, instead of plainly expressing itself as a lofty state floor, that first-floor is made of no more importance than the one over it. For want of plans, we cannot say whether such is really the case or not, but it does look very much as if, instead of containing a ball-room and other additional state apartments for public entertainments, the new building was intended to consist entirely of offices in its lower part, and in its upper one to afford the same sort of residence and lodging accommodation as has hitherto been provided in the original wings of the palace; and as if the latter—the south one at least—was now to be cleared out and converted into a ball-room, &c., in immediate connection with the present grand staircase. Unless one of the wings is to be entirely re-arranged internally, we do not see how there can be any suitable communication between the present state apartments and any others in the new building. By referring to the plan of Buckingham Palace, as given in the second edition of "The Public Buildings of London," it will be seen that by forming an approach from the grand staircase into the spacious octagon room on that side, converting that octagon into an ante-saloon to a ball-room or other spacious and lofty hall for public entertainments, made to occupy the whole of that wing and what will be added in depth by the new building (making altogether about 250 feet from the octagon), a most important addition might have been made to existing state apartments, in their immediate propinquity, but at the same time so as to keep the one suite perfectly independent of the other, at the same time allowing them both to be thrown open at once, with direct communication between them whenever the occasion might require it. The arrangement we have pointed out could hardly fail to be productive of an unusual degree of architectural display—of both effect and climax, even were the 250 feet of length from the octagon divided into two halls of entertainment, a larger and smaller one, the former being of course placed last. But we ourselves are now building—not exactly a palace, but a mere castle in the air. We must therefore, be content to let what we have been saying pass for mere moonshine.

Said, perhaps, it may be, that after all, the public need not give themselves any concern whatever about internal arrangement and accommodation; since all that will fall to their share will be external appearance alone. One circumstance will certainly be in favour of the New Building, namely, it being about ten or twelve feet higher, and being advanced so much forwarder it will show itself more conspicuously; at the same time, owing to its forming a single general mass, it will not possess any play of perspective, nor any of that relief and contrast of light and shade which now take place when the sun strikes on one of the wings on its side towards the court while the rest is in shadow. The aspect of the Park

front of the Palace is certainly an unfortunate one,* it being such as to render that façade a mass of shadow,—an inconvenience which it has been attempted to keep out of sight in the pictorial perspective view accompanying the two elevations by a device far more ingenious than praiseworthy, the sun being there made to shine upon the building from the north-east, which graphic fiction, besides setting off the east front itself to full advantage, performs the very good-natured service also of throwing into shadow the south side,—whereas, in reality, the effect will be just the reverse, since the latter, which forms no architectural façade at all, but is, on the contrary, an arrant jumble, will be lit up by the sun, while the Park façade will be buried in shadow. Nevertheless, such is the truthfulness of a drawing "presented to both Houses of Parliament," in order to enlighten their æsthetic optics. For our part, we very much question if any of those noble personages who affixed their signatures to what was presented to them, so much as noticed the fiction palmed upon them.

Having to contend with an unfavourable aspect, Mr. Blore ought to have exercised his ingenuity by studying how not only to overcome that disadvantage, but elicit some unusual effects. He might have taken a hint from those exceedingly picturesque bits of architecture, the open loggias in the Terrace façade of Somerset place. Something of that kind, admitting a brilliant light through a double range of columns seen in bold relief against the sky (for the buildings in the rear would not be visible), would have imparted no small degree of scenic vivacity to the whole façade. Nor would such arrangement have necessarily destroyed all communication between the rooms on the principal floor, because such communication might have been sufficiently kept up by means of a corridor practised behind the loggia, carried up only so high as not to be visible from the Park. Had there been any opening of the sort through the centre of the new building, it would surely have conducted very much to the cheerfulness of the inner court and the view from the portico and rooms on each side of it in the body of the palace, by admitting a glimpse of the trees in the park, between the columns.† At present, unwelcome as the truth may be, and ungracious as it may sound, we must say that the architect does not seem to have studied the subject at all; on the contrary, to have taken up with the very first ideas that presented themselves. Most assuredly, he has stolen none from Inigo Jones's designs for Whitehall, nor—not to go out of our own country—has he caught any of that grandiosity which stamps Greenwich Hospital—a pile that, although not faultless in taste, has infinitely more the air of a royal palace than anything we now have, not even Windsor Castle excepted. Had Mr. Blore been compelled to adhere as nearly as possible to the character of what had been before done, that consideration might have mitigated criticism; but for excuse of that kind he has left himself no room whatever, the new building being treated quite differently, yet in such manner as to leave it very questionable whether the difference amounts upon the whole to much improvement;—it most decidedly does not so much as the opportunity afforded. In one respect, there will be even more littleness than before, owing to a low entresol with a series of small windows being here introduced between the ground-floor and first-floor. That entresol, no doubt, supplies a great deal of accommodation for domestics, but in the front of a royal palace, and what is in this case the only public front of it, such trivialities should not be allowed to intrude. In such convenience ought to give way to dignity, and be provided for elsewhere; just as a sovereign must frequently sacrifice his own comfort and personal indulgence to state, and give an audience when he would much rather take a nap.

* Unfortunate, too, it is that that of the River front of the Palace of Westminster, and of the new Treasury buildings is just the same; nor, although different, is that of the Club-houses in Pall-Mall much better. However good they may be in themselves, buildings so circumstanced may be compared to good pictures hung in a very bad light. We may perceive what the details are, but they do not produce the intended effect,—not that which they do when the sun does fall upon them, which for about one half of the year it does not do at all at any time of the day. Aspect, however, notwithstanding all that is said about it, does not seem to be taken into account at all—not even so much as thought of for a moment in designing a façade. Hence, while we often see bareness in fronts fully exposed to the sun, and where ornament would consequently show itself well, we sometimes see a great deal of excellent detail almost all but quite thrown away upon others where owing to want of requisite light it does not produce any adequate degree of effect.

† We have now before us upon paper three several ideas, all widely differing in other respects, but all agreeing in providing a striking degree of effect of the kind mentioned. One of them extends the façade as far as the extremity of the present small Doric colonnades, so as to obtain a "corps de logis" north and south, of about 200 feet frontage, and connects those two masses of habitable building by a magnificent Corinthian colonnade on the level of the state floor, entirely open in its upper part, but having the intercolumns filled in, both towards the court and the Park, for rather more than half their height, by being glazed with brilliant stained glass, the effect of which, with the sun on the opposite side, could not fail to be most splendid. Internally, that part would form a conservatory or winter-garden, into which one of the new state rooms for evening entertainments would open; accordingly, when lit up of an evening, on any such occasion, the appearance would have been that of a superb illumination, with a series of glowing transparencies.

gant tyrannical priestcraft on the one hand, and of the most grovelling and besotted superstition on the other.

IV. When he was paying a tribute to the artistic talent of Vanbrugh—an architect gifted, if not with taste, with real conceptive power, and that in a prosaic age,—Reynolds might very properly have thrown out a compliment to Hawksmoor, and quoted the campanile of St. George's, Bloomsbury, as a most strikingly happy composition,—one on which the eye of a painter cannot but rest with delight. Happy as it is in itself, that masterly production has been made a martyr—not to criticism, but to stupid ridicule,—to the prosing imbecillity of such old women as Ralph, and the school-boy pertness of such clever coxcombs as Master Horace.—Criticism forsooth!—why criticism rejects such grovelling, feeble-wit stuff, and leaves it to *Punch* and the penny-a-liners. Had he possessed aught of critical faculty, it would have enabled Walpole to perceive how beautifully the statue *poses* upon, how admirably it *completes*, and how essential it is to the artistic completion of the ensemble. It is not an historic statue, elevated to such a height that the personality it is intended to figure to us is utterly lost; nor is it hoisted on a pedestal of its own, clapped upon the top-heavy capital of an overgrown column—a truly unhappy combination, productive of the most harsh abruptness of outline at the general summit. Here, on the contrary, the statue is incorporated with the architectural mass, of which it is the efflorescence, springing out of it as its finial or acroterion, and continuing to a point the lines of the obelisk-shaped part of the structure which it crowns.

V. Though it does not say much for Allan Cunningham's diligence or fitness for the task he undertook, it is perhaps as well that he omitted a memoir of Hawksmoor, for it would, in all probability, have proved little more than a mere re-echo of such senseless judgments as that of him who has pronounced St. George's steeple to be "a masterpiece of absurdity"!—Would that our modern architectural absurdities were but half as poetical, as graceful, and as picturesque! In regard to that stupidly calumniated church, there is another curious fatality, for no one has ever bestowed even so much as a syllable upon its north façade. Indeed, it may be fairly questioned whether it is yet known to exist, for of the thousands who pass the portico, scarcely one, perhaps, suspects that the other side of the building shows a piece of architecture of no ordinary merit—certainly one marked by no ordinary degree of architectural energy; and so far affording an excellent and much-needed study. Still, I may be committing mischief by thus calling attention to what is by no means calculated to put us into better conceit with what has since been done upon any similar occasions. Improved we may have in some respects—such, perhaps, as normal correctness of design, and normal attention to matters of detail; but we seem, on the other hand, to have lost the valuable qualities of boldness and vigour. If we are more refined, we are also more emasculated in our taste, and our buildings show as opera castrati—Buckingham palace being one of the puniest of them—by the side of such architectural "thaws and sinews" as Vanbrugh and Hawksmoor put into their works. Unluckily, however, architects seldom look to more than "orders" and other mere matter-of-fact circumstances, without perceiving, or if they perceive, without noting and investigating, artistic qualities—some of them so subtle as to elude satisfactory explanation; consequently, much less are they reducible to exact technical definition. We have, however, only to compare any one of Wren's churches with this of Hawksmoor's, to be able to account for one great difference of quality—the flatness and poorness which set their mark on the former, and the energy of expression which stamps the other. Although not entirely, this difference in a great measure arises from what is a very simple matter in itself, namely, the lesser or greater degree of relief produced according to the shallowness or depth of the external embrasures of the windows—in other words, accordingly as the plane of the glazing is approached to or set back from the plane or external surface of the wall. In the windows of all Wren's churches, there is scarcely any reveal; in Vanbrugh's and Hawksmoor's buildings, great depth of reveal—a difference that does not show itself in geometrical elevation, but which is an exceedingly important and influential one in perspective effect—consequently, in the buildings themselves; for while the former mode is attended by the insipidity arising from the absence of boldly-defining shadows, and of corresponding lights on the opposite sides of the apertures, the other secures them. Besides which, we are impressed in the one case with the disagreeable idea of the walls

being unusually thin, while in the other we at once perceive that they are unusually thick and substantial.

VI. The north side or front of St. George's, Bloomsbury, has escaped the notice of architectural draftsmen as completely as it has that of other people; which, to whatever else it may be owing, most certainly cannot be because it would not show well as a subject for the pencil. In that respect, however, it is by no means singular, for hundreds and hundreds of subjects for architectural delineation in the metropolis might be pointed out, which are yet absolutely untouched, although draftsmen go or appear to go again and again to very spots and places where they are to be found. Entirely fresh pictorial representations of them might easily enough be made of buildings which, although they have been shown again and again, are shown almost invariably in just one and the same way, and that their most formal and unpicturesque attitude. Now, it is all very well to have such a general view of a building as serves to exhibit it in mass, but we do not want so many repetitions as we get, of what is identically the same view,—unless, indeed, there be visible improvement also in regard to architectural delineation and artistical effect. Instead of which, deterioration is far more frequent than improvement, and many views of the kind that are published are only wretched, vamped-up copies of better ones which have preceded them.

VII. Many both extol the simplicity of Grecian architecture and speak of simplicity itself in the abstract, as if it were the most excellent and paramount quality in art, and which ought therefore, on every occasion alike, to be the predominating one. Not content with admiring simplicity themselves, they insist not only that others shall admire it too, but that, like themselves, they shall admire it exclusively, and be intolerant of the qualities opposite to it, even though they should be so applied as to be merits. Of Grecian architecture, the simplicity was by far too much of exactly the same kind. The simplicity of one building just resembled the simplicity of another; and, in fact, the simplicity was in a great measure quite involuntary, and of a rather negative kind, arising as it did chiefly out of the absence of complexity, or any other counteracting circumstances. How could it fail to be obtained in buildings constituted like the temples of the Greeks, which admitted of no combination, scarcely any other variations from one uniform general design than as they were tetrastyle, hexastyle, or octastyle, and deriving their individual character entirely from the particular order employed, and the nuancing given to it in its details and execution? As far as we ourselves are concerned, pure Grecian architecture is all very well for us in theory, but not to be thought of by us for actual practice. We may study the Parthenon as we study the Iliad, but would do well to desist from copying the one until we begin seriously to think of imitating the other, and endeavour to bring the lofty Epic strain into fashion again.

VIII. It looks very much as if the decision of the Army and Navy Club had been arrived at in deference to Count D'Orsay's opinion, as expressed by him in a note to the *Builder*, contradicting what had been rumoured as to his being concerned with Messrs. Parnell and Smith's design (No. 46), but expressing his hearty approbation of the design itself—of "the taste which selected one of the most beautiful palaces (palazzi) in Europe for the model," and declaring, that for the embellishment of the metropolis he should very much like to see it executed. It is singular enough, I may remark, that what is "one of the most beautiful" pieces of architecture of its kind in Europe—viz., the Palazzo Cornaro at Venice, by Sansovino, should hitherto have obtained so very little notice—scarcely any at all, beyond the mere mention of its name—from either architectural writers or cognoscenti travellers. Woods, for instance, does not even name it. We ought, therefore, to be the less surprised at the Club's not being struck by its pre-eminent merits, until their eyes were couched by the Count,—and had they discerned them before, they would doubtless have awarded the second premium, at least, to Messrs. Parnell and Smith. All that we ourselves can now recollect of that design is, that we merely glanced at it and passed on, perceiving at once that it was a direct and very palpable copy of some Venetian architect of Sansovino's time; and we wanted not to look at mere copies and leaves out of books, or published designs, but to discover what fresh ideas had been produced for the occasion. In what position, then, do Messrs. P. and S. put themselves, if not in that of mere architectural transcribers? And in what position is architectural design now put, except that of mere copyism, to which a bonus is thus directly held out by the success of those who are unable to produce anything suffi-

buildings in the metropolis, and other parts of England, which still remain to prove his skill as a builder, as well as his taste and science as an architect. In his seventeenth year, he was placed as a domestic clerk, or pupil, with Wren. His genius is unquestionable, but his taste not of the most refined order—nearer approaching the bold flights of Vanbrugh than the chastened correctness of his master. His knowledge of every science connected with his art is allowed, and his character has been spoken of, from authority, with commendation. He was deputy-surveyor, under Wren, at the building of Chelsea college, and clerk of the works at Greenwich hospital; in which offices he remained during the reigns of William, Anne, and George I., at Kensington, Whitehall, and St. James's. He was appointed superintending surveyor to all the new churches, and of Westminster abbey after the death of Sir Christopher; and designed many that were erected in pursuance of the statute of Queen Anne, for building fifty new churches.

Hawksmoor's best works are the churches that he built pursuant to the above-named statute: among which are, Christ church, Spitalfields, that was seriously injured a few years since by a destructive fire—but which, owing to the substantial nature of its construction, did comparatively little damage to the body of the fabric;—the church of St. George, Middlesex, called St. George's in the East, to distinguish it from its namesake in Bloomsbury: this is also a large and capacious edifice, with a singular tower, which with its lofty flag-staff, when viewed from the opposite side of the river, looks, amidst the forest of masts with which it appears to be encircled, like a tall ship with its white sails dangling from the topmast;—its neighbour, St. Anne, Limehouse, alike distinguished for originality of design, solidity of construction, and utility of its interior arrangements;—and St. George's, Bloomsbury, which has been condemned by hasty critics, from not falling within their narrow rules of art. This church is a bold, original, and striking composition, built in a masterly and scientific manner, and designed in a masculine style. The interior is commodious, appropriate, and picturesque—worthy of its author, his master, and his school. The portico, of the Corinthian order, is remarkably handsome and well proportioned, and the tower is placed in a judicious and proper situation. The steeple is novel, ingenious, and picturesque; and the statue of George I., in spite of the epigram, looks like the father of his people, surveying his good city with complacency, and holding forth his protecting hand over it. Nor must his beautiful church of St. Mary Woolnoth, Lombard-street, be forgotten. Its exterior is singularly substantial and well proportioned; its twin towers, resembling, in application only, those of some of our Gothic cathedrals, look particularly striking from Mansion-house-street, since the destruction of the old houses by which it was formerly surrounded, and the opening of the vista of King William-street, to which it forms a beautiful architectural foreground. The interior is well arranged for the service of the Anglican church, and is characterised by a most happy union of elegance and substantiality. The proportions of the Corinthian order that support the richly-panelled roof and coffered ceiling are scarcely inferior to those in the interior of Wren's masterpiece—St. Stephen's, Walbrook. A correct and well-engraved plan and section of this church are given in Britton and Pugin's 8vo. work of "London Edifices."

Hawksmoor also rebuilt part of All Souls college, Oxford, but, I believe, from Wren's designs; as also the mansion of Easton Neston, in Northamptonshire; restored a defect in Beverley minster with great skill; and repaired the west end of Westminster abbey in a judicious manner: and at Blenheim and Castle Howard was associated with Vanbrugh. He died in March, 1736, in nearly his seventieth year.

The witty, but too often indecent, Vanbrugh, of whom Pope says—

"Van wanted grace, but never wanted wit,"

contributed in a considerable degree to the architectural reputation, as well as the dramatic literature, of his country. Blessed with considerable talents, good education, and manners deteriorated by a profligate age, Vanbrugh figured as a gentleman, a dramatic author, a builder and manager of theatres, a herald, and a would-be engineer. Swift ridiculed this latter propensity and his ludicrous imitation of a fortified residence in his Vanbrugh castle, Greenwich, by saying, that he expected the queen (Anne) would

"make next year
A mousetrap-man chief engineer."

In 1696, shortly after the commencement of Greenwich hospital, Vanbrugh was appointed secretary to the commissioners, on the nomination of Mr. Evelyn. In 1716, he was appointed surveyor of the works at Greenwich hospital, comptroller general of his majesty's works, and surveyor of the gardens and waters: thus superseding his illustrious predecessor, who was still in the full possession of his faculties. This was not the only insult

that this eminent architect had to encounter, at a time when bribery and corruption existed in a greater degree than ever before known in English history. Mr. Ker, of Kersland in Scotland, asserts in his autobiography, that "it is very well known that Mr. Benson was a favourite of the Germans; and I believe nobody had more occasion to be convinced of the power of this influence than myself: so great, indeed, that Sir Christopher Wren, the famous architect who contrived the stately edifice of St. Paul's church, and finished it in his own time, was turned out of his employment of being master of the King's works, which he had possessed with great reputation ever since the Restoration, to make way for this favourite of foreigners." The influence of Benson over the king and his German advisers, obtained by means to which Wren could not stoop, was so great, that even Walpole, who resisted, with just indignation, an open offer of a large sum, which Benson made to the minister for a place for his son, was obliged to succumb to this back-stairs influence.

Benson and Vanbrugh were thus in full possession of Wren's offices, the principal of which Wren had held, with unparalleled honour and abilities, for nearly half a century. But what a contrast did these disgraceful transactions present! Benson held the situation scarcely a twelvemonth, with unexampled incapacity, and was disgraced by an ignominious expulsion from his office to avoid a prosecution, and by an immortality in the "Dunciad;" while Wren retired to a peaceful home at Hampton Court.

In the first edition of the "Dunciad," this architectural empiric is thus celebrated:—

"Beneath his reign shall Eusden wear the bays,
Cibber preside Lord Chancellor of plays,
Benson sole judge of architecture sit,
And namby-pamby be preferr'd for wit."

In the subsequent editions the poet altered these lines to—

"See, see, our own true Phœbus wears the bays!
Our Midas sits Lord Chancellor of plays!
On poets' tombs see Benson's titles writ!
Lo! Ambrose Phillips is preferr'd for wit!"

And in a note he adds—"In favour of this man, the famous Sir Christopher Wren, who had been architect to the crown for above fifty years, who built most of the churches in London, laid the first stone of St. Paul's, and lived to finish it, had been displaced from his employment at the age of near ninety years."

But of Wren our great poet says:—

"See under Ripley rise a new Whitehall,
While Jones' and Boyle's united labours fall;
While Wren with sorrow to the grave descends,
Gay dies unpension'd with a hundred friends."

Vanbrugh built the first theatre in the Haymarket, and managed it conjointly with Congreve. It is singular that this theatre has been rebuilt by the late John Nash, himself an actor, manager, and architect. An eminent comedian of the present day, who was originally an architect and joint surveyor to a public company with the author of this article, before he had quite abandoned his former profession, requested him to state in his "Life of Wren," as an apology for his uniting the two professions, that in addition to Vanbrugh and Nash, might be added the name of our great English Vitruvius, as being an actor as well as an architect. He informed me that in an old quarto play, translated from the "Plutus" of Aristophanes, is the following manuscript remark, in the handwriting, and with the signature, of Isaac Reid, the commentator:—"This is the play in which Sir Christopher Wren, our great English architect, performed the character of *Neonias*, before the Elector Palatine, Dr. Seth Ward, and many others, probably in 1652."

The works of Vanbrugh are solid and judicious; but he neglected the lighter graces of his art, and is, in spite of all his picturesque beauties, cumbrous and inelegant in detail. Swift's epigram on this architect is well, and in some instances he merited the satirist's

"Lie heavy on him, earth, for he
Laid many a heavy load on thee."

There is, however, another version in a rather better spirit, and more like the *ad levés* of the ancient Romans, and is

"Lie light upon him, earth, though he
Laid many a heavy load on thee."

Yet, Castle Howard and Blenheim will keep alive the memory of the witty and accomplished Vanbrugh among those of our greatest architects. A fair specimen of his picturesque and singular style may be gathered from his own house near the Privy-gardens, which was also a subject of Swift's satire, who compared it to a dirt pie heaped up by children.

Sir Joshua Reynolds, in his inimitable discourses on painting, gives great and deserved praise to the artist-like compositions of this architect, particu-

ciently passable of their own—such, at least, is the very natural inference, because no one who has any power as an artist would voluntarily forego the opportunity of displaying it, and take up with other men's ideas, when he might bring forward his own,—least of all so, when that opportunity is one which does not present itself every day, but is, on the contrary, an exceedingly rare one. Not a little curious it surely is, that of two club-houses, one partly executed and another about to be begun, the designs should be by Jacopo Tatti—or, to give him the name he is more generally known by, Jacopo Sansovino. Not less extraordinary is it, that in what calls itself a Fine Art, wholesale plagiarism of the kind should be practised without so much as any attempt at concealment, just as if it were decidedly meritorious instead of being at all reproachful. To endeavour to appropriate to ourselves the excellencies of former works is not only allowable, but praiseworthy; yet, to be legitimate, such appropriation must be that which results from that thorough study of the original, which enables us to extract from it its better qualities and finer essence, and to infuse them into what the express occasion demands.

HISTORY OF ARCHITECTURE IN GREAT BRITAIN.

A Brief Sketch or Epitome of the Rise and Progress of Architecture in Great Britain. By JAMES ELMES.

"Epitomes are helpful to the memory, and of good private use."

SIR HENRY WOTTON.

(Continued from page 238.)

Wren's immediate successors were his cotemporary, Sir John Vanbrugh; his friend and colleague, Robert Hooke; his pupil, Nicholas Hawksmoor; Gibbs, who finished the church of St. Clements Danes; and a few others of less notability.

Robert Hooke was the assistant and sometimes rival of Wren, during the greater part of that architect's career. He, like Wren, was an experimental philosopher; like him, had received a doctorial degree, when that honour was conferred only upon men of first-rate talent. To use a theatrical phrase, Hooke may be considered as Wren's double, and took the part of his principal whenever called upon. Hooke added much to the useful inventions of the day, as may be seen in his memoirs by Dr. Waller, and in the cotemporary proceedings of the Royal Society. He appears to have been more of an imitator than an inventor, for when Wren, or any other original genius of the day, brought forward a scheme or an invention, Hooke was always ready with another of a similar nature.

The great and extensive charge which devolved upon Wren after the fire of London, induced him to take to his assistance his ingenious and able associate, Robert Hooke, the learned professor of geometry at Gresham college; whose avocations, under Wren, were chiefly those of measuring, adjusting, and setting out the ground of the houses in the private streets to the several proprietors, while he reserved the higher and more important works of designing and superintending the execution of the public works to himself. Hooke, at the same time, divided the labours and honours of the Royal Society with Boyle, Moray, Wren, and other philosophical members. Among the subjects submitted by Hooke to the Royal Society, were a new method of making bricks, with less charge and more speed than had been then practised, and a design for a collegiate building for the use of the Society, to be built on a site of ground presented to them by their munificent associate, Mr. Howard of Norfolk. This volunteer design did not please the Society, nor did the manner in which Hooke appeared to trench upon his master's ground, for at a meeting of the council on May 4, 1668, the president (Lord Brouncker) moved, that the building of the Society's college might be begun forthwith, and Dr. Wilkins was desired to procure, at the next meeting of the council, Dr. Wren's design for the building.* This was done, and Hooke ordered to get a model made of the approved design, to contract with proper persons for the execution of the work, as also to find someone to be constantly present, and to see the workmen do their duty; thus appointing Wren as architect, Hooke as surveyor and valuer, with a resident clerk of the works.

Of Hooke's repeated invasions into his master's province, abundant proofs are found in the records of the Society, and Wren at last complained of

these interferences. Few men had more reason to say *sic vos non vobis* than Wren. Hooke appears throughout to have followed, thrust, and attempted to supersede in the public estimation his friend, patron, and principal, in every thought, invention, and discovery. Not content with his inroads upon Wren's reputation, he dared to impugn the philosophical theories of the then youthful Newton, whose important discoveries were the constant theme of the discussions of that eminent Society of which he had just been admitted a member. It may not be irrelevant to mention in this place, that this greatest of modern philosophers was, at the commencement of his illustrious career, in such straitened circumstances, that it is recorded, in the history of the Royal Society for 1675, that at a meeting of the council, Mr. Oldenburg having mentioned that Mr. Newton had intimated his being in such circumstances, that he desired to be excused from the weekly payments, it was therefore agreed to by the council that it should be dispensed with. Hooke's audacity in impugning the doctrines of our great philosopher is not without its parallel, even in our own times, when the truth of all his theories has been so firmly established. The late Sir Richard Phillips, author of many clever imaginative works, has informed the writer of this article more than once, that all he desired after his death, was to be buried in Westminster Abbey, and to have inscribed upon his tomb—"HERE LIES THE REFUTER OF SIR ISAAC NEWTON."

Hooke's attempts to supersede Wren have been alluded to. Among the most prominent is that recorded in the transactions of the Royal Society, of his submitting to the council on September 19, 1666, a model for rebuilding the city, with which the Society is said to have been well pleased. It appears that he had previously shown it to the lord mayor and some of the aldermen of the city, as Sir John Laurence, the late lord mayor, addressed himself to the Society, and expressed the lord mayor's (Sir Thomas Bludworth) and aldermen's approbation of the said model, and their desire that it might be shown to the king, they preferring it very much to that which was drawn up by the city surveyor. The president answered, that the Society would be very glad if they or any of their members could do any service for the good of the city; and that Mr. Hooke should wait upon the king with them and his model, if they (the lord mayor and aldermen) thought fit to present it: which was accepted, with expressions of thanks to the Society.

Dr. Waller, in his life of Hooke, affects to wonder why this model was not accepted. The reason was, that the superior and more digested plan of Wren, to say nothing of Evelyn's, had been previously before the king and council. Wren had no opportunity to communicate his design either to the Royal Society or to the city authorities, before it was sent to the king; and it is probable that neither of these bodies had then seen it.

Hooke is believed to have been the architect to the Duke of Montague's house in Bloomsbury, afterwards the British museum, and recently pulled down to make room for Sir Robert Smirke's improvements. Of his authenticated works, the best are the royal Hospital of Bethlehem, which formerly stood on the site now occupied by Finsbury-circus, Moorfields,—and Aske's Hospital, at Hoxton, built and endowed by Sir John Aske, an alderman and past lord mayor of London, for the use of aged and decayed liverymen of the worshipful company of haberdashers, of which he was a liberal and distinguished member. The former of these buildings had a Frenchified palatial look, not in accordance with its destination—a hospital for lunatics; and the latter, a collegiate appearance, with colonnaded ambulatories for the aged inmates, a hall and chapel for their accommodation, and a school for the education of orphan boys of the company, with a handsome statue of its founder in the centre. The style of both these buildings may be seen in the various illustrated histories of London; and a large perspective drawing of Aske's Hospital, by the architect, is among the pictures that decorate the court room of the haberdashers' company, who are the trustees and governors of the hospital. This building has also been pulled down, and its place supplied by one of smaller dimensions, and of less architectural pretensions.

It must be recorded, however, to the honour of Robert Hooke, that he, Boyle, and Wren, formed that illustrious trio of philosophers that paved the way to the important results established by Sir Isaac Newton.

He died, after a long and useful life, on the 3rd of March, 1705, in the 68th year of his age. He was buried in the church of St. Helen, Bishopsgate, and was attended to his resting-place by all the members of the Royal Society who were then in London.

Hawksmoor, the pupil of Wren, one of the most original and inventive architects that England has produced, was born, singular enough, in 1666, the year of the great fire of London. He erected many fine and substantial

* Birch's Hist. Roy. Soc. Vol. II. p. 273.

buildings in the metropolis, and other parts of England, which still remain to prove his skill as a builder, as well as his taste and science as an architect. In his seventeenth year, he was placed as a domestic clerk, or pupil, with Wren. His genius is unquestionable, but his taste not of the most refined order—nearer approaching the bold flights of Vanbrugh than the chastened correctness of his master. His knowledge of every science connected with his art is allowed, and his character has been spoken of, from authority, with commendation. He was deputy-surveyor, under Wren, at the building of Chelsea college, and clerk of the works at Greenwich hospital; in which offices he remained during the reigns of William, Anne, and George I., at Kensington, Whitehall, and St. James's. He was appointed superintending surveyor to all the new churches, and of Westminster abbey after the death of Sir Christopher; and designed many that were erected in pursuance of the statute of Queen Anne, for building fifty new churches.

Hawksmoor's best works are the churches that he built pursuant to the above-named statute: among which are, Christ church, Spitalfields, that was seriously injured a few years since by a destructive fire—but which, owing to the substantial nature of its construction, did comparatively little damage to the body of the fabric;—the church of St. George, Middlesex, called St. George's in the East, to distinguish it from its namesake in Bloomsbury: this is also a large and capacious edifice, with a singular tower, which with its lofty flag-staff, when viewed from the opposite side of the river, looks, amidst the forest of masts with which it appears to be encircled, like a tall ship with its white sails dangling from the topmast;—its neighbour, St. Anne, Limehouse, alike distinguished for originality of design, solidity of construction, and utility of its interior arrangements;—and St. George's, Bloomsbury, which has been condemned by hasty critics, from not falling within their narrow rules of art. This church is a bold, original, and striking composition, built in a masterly and scientific manner, and designed in a masculine style. The interior is commodious, appropriate, and picturesque—worthy of its author, his master, and his school. The portico, of the Corinthian order, is remarkably handsome and well proportioned, and the tower is placed in a judicious and proper situation. The steeple is novel, ingenious, and picturesque; and the statue of George I., in spite of the epigram, looks like the father of his people, surveying his good city with complacency, and holding forth his protecting hand over it. Nor must his beautiful church of St. Mary Woolnoth, Lombard-street, be forgotten. Its exterior is singularly substantial and well proportioned; its twin towers, resembling, in application only, those of some of our Gothic cathedrals, look particularly striking from Mansion-house-street, since the destruction of the old houses by which it was formerly surrounded, and the opening of the vista of King William-street, to which it forms a beautiful architectural foreground. The interior is well arranged for the service of the Anglican church, and is characterised by a most happy union of elegance and substantiality. The proportions of the Corinthian order that support the richly-panelled roof and coffered ceiling are scarcely inferior to those in the interior of Wren's masterpiece—St. Stephen's, Walbrook. A correct and well-engraved plan and section of this church are given in Britton and Pugin's 8vo. work of "London Edifices."

Hawksmoor also rebuilt part of All Souls college, Oxford, but, I believe, from Wren's designs; as also the mansion of Easton Neston, in Northamptonshire; restored a defect in Beverley minster with great skill; and repaired the west end of Westminster abbey in a judicious manner: and at Blenheim and Castle Howard was associated with Vanbrugh. He died in March, 1736, in nearly his seventieth year.

The witty, but too often indecent, Vanbrugh, of whom Pope says—

"Van wanted grace, but never wanted wit,"

contributed in a considerable degree to the architectural reputation, as well as the dramatic literature, of his country. Blessed with considerable talents, good education, and manners deteriorated by a profligate age, Vanbrugh figured as a gentleman, a dramatic author, a builder and manager of theatres, a herald, and a would-be engineer. Swift ridiculed this latter propensity and his ludicrous imitation of a fortified residence in his Vanbrugh castle, Greenwich, by saying, that he expected the queen (Anne) would

"make next year
A mousetrap-man chief engineer."

In 1696, shortly after the commencement of Greenwich hospital, Vanbrugh was appointed secretary to the commissioners, on the nomination of Mr. Evelyn. In 1716, he was appointed surveyor of the works at Greenwich hospital, comptroller general of his majesty's works, and surveyor of the gardens and waters: thus superseding his illustrious predecessor, who was still in the full possession of his faculties. This was not the only insult

that this eminent architect had to encounter, at a time when bribery and corruption existed in a greater degree than ever before known in English history. Mr. Ker, of Kersland in Scotland, asserts in his autobiography, that "it is very well known that Mr. Benson was a favourite of the Germans; and I believe nobody had more occasion to be convinced of the power of this influence than myself: so great, indeed, that Sir Christopher Wren, the famous architect who contrived the stately edifice of St. Paul's church, and finished it in his own time, was turned out of his employment of being master of the King's works, which he had possessed with great reputation ever since the Restoration, to make way for this favourite of foreigners." The influence of Benson over the king and his German advisers, obtained by means to which Wren could not stoop, was so great, that even Walpole, who resisted, with just indignation, an open offer of a large sum, which Benson made to the minister for a place for his son, was obliged to succumb to this back-stairs influence.

Benson and Vanbrugh were thus in full possession of Wren's offices, the principal of which Wren had held, with unparalleled honour and abilities, for nearly half a century. But what a contrast did these disgraceful transactions present! Benson held the situation scarcely a twelvemonth, with unexampled incapacity, and was disgraced by an ignominious expulsion from his office to avoid a prosecution, and by an immortality in the "Dunciad;" while Wren retired to a peaceful home at Hampton Court.

In the first edition of the "Dunciad," this architectural empiric is thus celebrated:—

"Beneath his reign shall Eusden wear the bays,
Cibber preside Lord Chancellor of plays,
Benson sole judge of architecture sit,
And namby-pamby be preferr'd for wit."

In the subsequent editions the poet altered these lines to—

"See, see, our own true Phœbus wears the bays!
Our Midas sits Lord Chancellor of plays!
On poets' tombs see Benson's titles writ!
Lo! Ambrose Phillips is preferr'd for wit!"

And in a note he adds—"In favour of this man, the famous Sir Christopher Wren, who had been architect to the crown for above fifty years, who built most of the churches in London, laid the first stone of St. Paul's, and lived to finish it, had been displaced from his employment at the age of near ninety years."

But of Wren our great poet says:—

"See under Ripley rise a new Whitehall,
While Jones' and Boyle's united labours fall;
While Wren with sorrow to the grave descends,
Gay dies unpension'd with a hundred friends."

Vanbrugh built the first theatre in the Haymarket, and managed it conjointly with Congreve. It is singular that this theatre has been rebuilt by the late John Nash, himself an actor, manager, and architect. An eminent comedian of the present day, who was originally an architect and joint surveyor to a public company with the author of this article, before he had quite abandoned his former profession, requested him to state in his "Life of Wren," as an apology for his uniting the two professions, that in addition to Vanbrugh and Nash, might be added the name of our great English Vitruvius, as being an actor as well as an architect. He informed me that in an old quarto play, translated from the "Plutus" of Aristophanes, is the following manuscript remark, in the handwriting, and with the signature, of Isaac Reid, the commentator:—"This is the play in which Sir Christopher Wren, our great English architect, performed the character of *Nemias*, before the Elector Palatine, Dr. Seth Ward, and many others, probably in 1652."

The works of Vanbrugh are solid and judicious; but he neglected the lighter graces of his art, and is, in spite of all his picturesque beauties, cumbrous and inelegant in detail. Swift's epigram on this architect is well, and in some instances he merited the satirist's

"Lie heavy on him, earth, for he
Laid many a heavy load on thee."

There is, however, another version in a rather better spirit, and more like the *sit levis* of the ancient Romans, and is

"Lie light upon him, earth, though he
Laid many a heavy load on thee."

Yet, Castle Howard and Blenheim will keep alive the memory of the witty and accomplished Vanbrugh among those of our greatest architects. A fair specimen of his picturesque and singular style may be gathered from his own house near the Privy-gardens, which was also a subject of Swift's satire, who compared it to a dirt pie heaped up by children.

Sir Joshua Reynolds, in his inimitable discourses on painting, gives great and deserved praise to the artist-like compositions of this architect, particu-

larly as to his mode of making his buildings rise from the earth with judicious basements—not breaking abruptly from it, as if it had no foundation or connexion with the plot upon which it stands.

Vanbrugh was a bold and erratic genius in his art, picturesque and poetical in his imagination; rather resembling the painter-architects of Henry the Eighth's time, than a follower of Palladio, Jones, or Wren. Blenheim, near Woodstock in Oxfordshire, one of the best of his works, and the most characteristic of his peculiar style, was begun in 1705. It was intended as a tribute of a grateful nation to their illustrious soldier, but servile intriguer, the Duke of Marlborough, and was named after the greatest of his victories. The secret history of this transaction forms an amusing feature in D'Israeli's "Anecdotes of Literature;" but appertains more to the political intrigues than to the architectural history of our country.

In this period arose those prominent ornaments of our metropolis, the churches of St. Mary-le-Strand and St. Martin's in the Fields, from the designs of James Gibbs, who also finished that of St. Clements Danes, begun by Wren. Gibbs was an architect of the school of Wren, but affected by laborious detail and superabundance of ornament—as may be seen in his works, particularly in the interior of the church of St. Martin—what Wren accomplished by more simple and scientific means. The exterior of St. Mary-le-Strand is of two orders in height, which presupposes two stories to the interior—a fault committed by Jones in his Banqueting-house, Whitehall; and by Wren in his St. Paul's cathedral. The former has for an apology, that his building was part and parcel of an enormous palace, and corresponded with such portions of it that had two stories, and this required the omission of one for height in the interior. For Wren it may be said, that his two stories of coupled columns in the western front, have nearly the same proportions of one; and that viewing his cathedral from a distance—the best position for seeing its beauties—the lower order is entirely concealed from view by the houses that surround it. The circular portico in the western front of Gibbs's church in the Strand, is a palpable and clumsy imitation of Wren's beautiful semi-rotunda to the north and south transepts of St. Paul's. The summit of its cupola was to have been surmounted by a farthingaled statue of Queen Anne, somewhat like that horrible monstrosity in St. Paul's churchyard, for which was substituted the present funeral vase.

The exterior of St. Martin's in the Fields is in a bolder style and purer taste. The columns *in antis*, or, to speak less technically, the columns between the ante or pilasters, that form the retrocessed porticoes of the north and south aisles, are both novel and effective; and the Corinthian hexastyle portico of the western end would be unexceptionable, were it not for the cumbrous steeple that bears down its apex. No such monstrosity disfigures any of Wren's churches, whose steeples always rise from external and visible towers. The interior looks fine from a redundancy of ornament—divested of which, it would degenerate into common-place. It is, however, a large and commodious edifice, well adapted to the parochial church service of the establishment; the arrangement of which, Chambers did not disdain to imitate in his German Lutheran church in the Savoy, near Waterloo bridge.

Of Gibbs's other work, the Ratcliffe library, Oxford, it can only be called a practical blunder; for devoid of the necessary scientific skill in construction that is requisite to complete the character of an architect, he intended to have executed the cupola with stone, but it would not stand: it was obliged, therefore, to be taken down and to be built of lath and plaster.

Gibbs published a treatise on the "Elements of Architecture," which possesses nothing new, and is to be considered more as a student's guide to drawing the five orders of Italian architecture according to that master's proportions—which are not sufficiently correct to be considered as models—than a treatise on the art of which he aspires to be a teacher.

The state of architecture at the end of the reign of George II., and for some time previous thereto, had been as low as at almost any period of the English history. From the death of Kent and the great Earl of Burlington, two accomplished architects of the Anglo-Palladian school, to the commencement of the reign of George III., we have no account of any native architect worthy of notice. The profession seemed almost to have been lost; and new buildings, repairs, and alterations, to have been performed by that anomalous being, that sort of uno-dual mixture of artist and artisan, the building surveyor, or surveyor and builder, as he generally termed himself.

The school of architects which ended with Hawksmoor, had left no disciples, and the only one who can lay claim to the name was Archer, whom Walpole describes as holding the office of groom-porter in the royal palaces.

The church of St. John the Evangelist, Westminster, which has been falsely attributed to Vanbrugh, is characterised by a bold originality in its quadri-frontal form, of an Italian-Doric order, surmounted by four Corinthian turrets. It has been ludicrously compared by Swift, or some other satirist, to an elephant on its back, or a huge butcher's block reversed, with its clumsy legs rising upwards. But had it been finished as intended, with a lofty cupola or lantern in the centre, it would have had a different and perhaps a good effect.

As an example of the state of architecture and its patrons at this period, may be cited the fact, that when the corporation of London proposed building a mansion-house for the official residence of their lord mayors, Lord Burlington submitted to them an elegant design by Palladio, which the citizens rejected as being the work of a foreigner and a papist, and executed the present building from a design of the elder Mr. Dance, who was both a citizen and a Protestant. This architect has been said to have been originally a ship-builder, and the two lofty attics that were formerly over the Egyptian-hall and the ball-room have been sarcastically compared, from this circumstance, to the bulk-heads or poops of a deeply-laden Indiaman. The plan is well arranged for the purposes it was built for; some of the apartments are magnificent, though somewhat heavy in style, and there is no feature in any part of it but what may be traced to some of the then existing books on Italian architecture. The Corinthian orders of the portico and of the Egyptian-hall have more the character of the Stadt-house at Amsterdam, than those of any of the fair cities of Italy; and the whole building bears more affinity to the Batavian than to the Italian style of architecture.

Dance was, however, a man of some genius, and exhibited much skill in his churches of Bishopsgate and Shoreditch. The Roman-Doric portico of the latter is as well proportioned and as happily applied as any similar structure in the metropolis. The spire, though inelegantly placed behind the portico, which occasions its tower or basement to be hidden, and gives it the appearance of being mounted on the roof, is a free and successful imitation of Wren's St. Mary-le-Bow, and is one of the handsomest spires in London. The deeply indented scotia that supports the terminating obelisk is boldly original, is productive of a fine effect, and could only have been executed by a man of science. The bodies of both these churches present the appearance that their author had studied his Vitruvius in a Dutch translation.

Hogarth has satirised the want of architectural taste in England at this period in one of his inimitable pictures of *Marriage à la Mode*, where the portico of the mansion in progress for the noble father of the bridegroom, is formed of five columns, the middle one being under the apex of the pediment. The satirist little dreamt that his pointed ridicule would find an imitator, yet it is so, for the architect, if so he may be called, of Bedford-square, has on two of its sides perpetrated the atrocity of a sham portico of five attached pilasters, the middle one being after the mode of Hogarth's architect—under the apex of the pediment.

Batty Langley who flourished about this time, had a school or academy of architecture, but his disciples were all carpenters; and although his taste as an architect was deservedly derided, he formed a school of excellent workmen, and gave form to many a skilful artisan in a certain line of art.

Emlyn, in an after age, attempted the forlorn hope of inventing a new order of architecture, as if those of Greece and Rome and Italy were not sufficient for the grasp of his capacious mind. He used oak leaves instead of acanthus or parsley for foliage, the star of the order of the garter for the rosette between the volutes; the shaft was single, one-third of its height, where it divided itself into two, like a forked elm, and terminated of course with twin capitals. He was permitted to dedicate his book, entitled "EMLYN'S NEW ORDER OF ARCHITECTURE," to George III., who with that good nature which always characterised that monarch's patronage of artists, allowed him to execute a specimen of his biforked "*British order*," at Windsor: but I believe it has been removed.

Batty Langley however soared higher, for he published his invention of no fewer than five new orders, namely, *The Gothic Tuscan! The Gothic Doric!! The Gothic Ionic!!! The Gothic Corinthian!!!!* and *The Gothic Composite!!!!!!* The principal novelties were making the shafts of the columns treble, quadruple, and quintuple, clustered and banded like the pillars of our ancient cathedrals, making the tops of the triglyphs pointed like lancet windows, the friezes coved and filled with frets, and other equal absurd alterations. Some specimens of these "*Gothic orders of my invention*" were, and perhaps are, to be seen in a street near the north-east corner of St. James's-park,—Fludyer-street, I think.

During this state of transition, several elegant and substantial mansions of

considerable dimensions were erected in various parts of the country. Wanstead-house, a splendid edifice, with a magnificent Corinthian portico and extensive wings, worthy the name of a palace, was built by the opulent and plebeian family of the Longs; and has since been torn down, its pictures, statues, and materials sold, and the park disforested of its lofty oaks, by an aristocratic parvenu, who married and ill-treated the last heiress of the Tilney Longs. Harewood-house, near Leeds, in Yorkshire, one of the residences of the noble family of Lascelles, is a fine imitation, without being a servile copy of the mansion at Wanstead, but with the advantages of a fine situation, and of being surrounded by a truly princely demesne, and commanding some of the finest views in the country. The mansion of the late Sir Gregory Page, at Blackheath, a truly Palladian villa, on a vast scale, was too extensive for the fortunes of his successors, and met the fate of Wanstead-house. Some others, possessing no originality of character, were erected about this time some of them from the designs of Giovanni Battista Leoni, an Italian architect of skill and taste: the best of these are recorded, with plans, elevations, and sections, in the "Vitruvius Britannicus" of Colin Campbell, himself an architect of industry and talent.

Such was the state of architecture when George III. ascended the throne of his German ancestors, neither of whom loved art or literature, and one of whom could see no merit in the transcendent works of Hogarth, and abused him for ridiculing, as he said, his German guards in the celebrated picture of "The march to Finchley;" this offence the painter revenged by dedicating the print to Frederick the Great of Prussia. Nor could he discover any genius in Garrick, but talked German and took snuff while the British Roscius was illustrating Shakspeare's Richard the Third; but rose, commanded silence, and made an obeisance to the low-comedy actor who personated the lord mayor, saying, "Gentlemen, we must pay respect to my lord mayor." Such were the military goths who had the art, literature, and science of the kingdom, in an enlightened age, at their command.

Frederic, Prince of Wales, father of George III. received an English education, was a mild gentlemanly man of no great abilities, but possessed a real love for the amenities of literature and art. He patronised Thomson and Gay, and his little court was divested of the rougher manners of his father's. He was upon ill terms with his father, did not live happily with his wife, a princess of coarse mind and manners, and died young. The education of his son was thus left to the care of his mother, who neglected the more solid parts of his studies, and applied the money entrusted to her for that purpose to her own pleasures.

King George III., fortunately for the arts, and particularly architecture, was endowed with an innate love for such pursuits which soften and improve the human mind. He was also well acquainted, for a prince, with both the theory and practice of the graphic arts. When Prince of Wales, he studied architecture, under Mr. Chambers, and was taught to delineate its proportions with accuracy from the rules of Palladio and Vitruvius. From the before-mentioned circumstances, there was no Englishman who practised architecture as a profession. Chambers, who had been a naval officer, was partial to the art, and had travelled in countries where architecture was better understood than in England. The young Prince also studied the science of perspective, under Mr. William Kirby, whose practical work, founded on the theories of Dr. Brook Taylor, was formerly in much esteem, and has obtained great celebrity from Hogarth's sarcastic frontispiece of faults likely to occur from the want of a knowledge of that science. Prince George contributed, it is said, a design for his tutor's work; and his drawings are reported, by persons who had seen them, and they were extant in the royal library in the late Buckingham-house a few years since, to have been correct in detail, and, for their day and style of art, tasteful and elegant.

George III. ascended the throne of Great Britain with more advantages than most of his predecessors. Born and educated an Englishman, he gloried, as he said in his first speech from the throne, in the name of a Briton. Unpractised in the cruel scenes of warfare, he had been bred in peaceful retirement—perhaps too recluse for the government of a nation then involved in such momentous transactions. He loved art, was fond of literature, particularly that of his own country, was slightly skilled in music, and read Shakspeare with propriety and enthusiasm. A speech from the throne, delivered in correct and elegant English, was a novelty unknown to almost all its auditors. The exclamation of Quin, the tragedian, who had been his master in elocution, and was admitted to a place in the House of Lords to witness the debut of his royal pupil, of "Bravo! I taught the boy," was more sincere than courtly. Artists and literary men were no longer buffed for their intrusion into the palace, nor debarred the royal presence. Chambers was appointed to the office of royal architect. Ramsay, a well known portrait

painter, was employed to depict the youthful sovereign and his consort; other artists and their interests were attended to, and the management of the academy, or association of artists, in St. Martin's-lane, began by Hogarth, Thornhill, and others, was patronised, and its concerns investigated. The king concerned himself even with their little quarrels, and suggested measures for the enlargement of its utility; it being then merely a school of adult artists, for the study of the human figure, and not an academy of the fine arts, which the king desired to see established in England. It had, however, its series of annual public exhibitions of the works of its members, which the king duly honoured regularly with his presence.

Chambers, from the circumstance of being the royal architect, and repairs and additions to the royal palaces being necessary, had more interviews with his royal master than others; and their former relations of master and pupil, had given more than usual freedom of intercourse to these interviews. The king designed to establish a Royal Academy of painting, sculpture, and architecture, upon the plan of those founded by the illustrious Colbert and Cardinal Richelieu in France, and to build a palace for its occupation. The king entered into this grand project, and Chambers became the organ of communication between him and the leading artists of the day upon this important subject.

Having now adopted architecture as a profession, and being a Chevalier of the order of the Polar Star, his royal master honoured him with English knighthood, when such an honour was more rare than in later days. Hence the origin of the Royal Academy of the fine arts and the building of Somerset-house.

Sir William Chambers threw no new lights on the art over which he was destined to preside. In its practice and more scientific department of construction he was, comparatively with such men as Wren and Hawksmoor, totally ignorant. His taste was Roman, and, being unacquainted with the sublimer beauties of Grecian art, was consequently less refined; yet his works have a chastened correctness of detail of the best style of Italian art. He is less exuberant than Scamozzi, Serlio, and Borromini, and even than Palladio himself, except in his very best examples. He may be called the *Palladio riformato* of the Georgian era. In the course of his travels he had visited parts of China, and published a treatise on the gardening and architecture of that strange people. The royal gardens of Kew and its lofty pagoda are among the results of the Chinese phantasy that he had inflicted on his royal master, and led to the introduction of that fanciful and inelegant style. Yet the Somerset-house of this architect has many redeeming beauties, and his work on "Civil Architecture," in spite of bad taste in reviling the architecture of ancient Greece, of which he knew nothing, abounds with sound doctrines, and is the best elementary work that we possess. A new edition, remarkably well edited by the late John Buonarotti Papworth, whose recent death, full of years and honour, the profession have to deplore, was published a few years since, and also a smaller one, with a treatise on "Grecian Architecture," by Mr. Joseph Gwilt.

The establishment of the Royal Academy by George III. is the next great epoch in the arts of this country, after the fire of London, and will form the subject of the next section.

(To be continued.)

RAILWAY LEGISLATION, ACCIDENTS, AND INSPECTION.

A paper was published some short time ago, to show that if it had not been for the operation of prejudice, we might have been in as full possession of the railway system in 1817 as 1847, and that we had spent some half century in keeping back and thwarting improvements. Much the same kind of thing might be said of railway legislation: at this date we are fighting for the same points as we have been for years. Surely no bantling ever suffered so much from officious nurses than has the railway system; never were bandages, rollers, and go-carts more unmercifully applied to hinder, under the name of fostering, growth.

The pages of our *Journal* will show that we have always stood up against all legislative and government interference with any form of engineering enterprise. If this be a prejudice, we are quite willing to own it, and stand by it, and we have held most unflinchingly to it. It happens, however, that if we have stuck to a prejudice, our opponents have not fared in the least well with their several legislative and inspectional measures; and we are at this late hour strengthened in our views by their

ill-success, which they have on many occasions acknowledged. At all events, then, they cannot say that experience has been against us, whatever they may choose to say and think about the soundness of our theories.

We believe by this time everything has been planned and tried about the railway system, except letting it alone, but we very much fear this is the only experiment with it that will never be tried. It is, nevertheless, one encouragement to persevere, to us and other friends of non-intervention, that the experience as to railways, and the enlarged experience of every similar establishment and institution, results in confirming the propriety of our convictions.

In the teeth of the truism, that all human undertakings are fallible and all new undertakings imperfect, no allowance is made for the railway system, but every accident is seized hold to authorise its condemnation and restraint. The result of such interference has never been followed out, but a careful examination of railway accidents from the first returns would show, that while many accidents are due to carelessness beyond the control of any authority, still more are due to the progressive condition of the railway system, and still more to the attempts for the prevention of accident. Luggage trucks used at first to be put between the passenger carriages and the engine, to provide against the possibility of injury from explosion of the engine. A train having been run into from behind, the luggage and goods trucks were then, on the demand of the public, put behind. This was followed by an accident, from a train being injured from the front. The public then required trucks to be put fore and aft. Notwithstanding this, a train was cut in halves at a junction.

In order to give stability to the trains, it was an early practice to mix goods and passengers. This was, on the public voice, given up, but there was a demand for empty horse-boxes and luggage vans to be mixed with the trains for safety. We believe these have been the cause of very many accidents, from their unequal weight and construction leading to their being thrown off the way, and to the passenger carriages riding upon them.

From the public demand for signals, signal-men, and pointsmen, has resulted certainly no greater safety, but certainly many more accidents from neglect of signals.

While the jumble of passenger carriages, trucks, and horse-boxes might do very well for the 20-mile-an-hour speed of 1836, it is very unsuited for the 50-mile-an-hour speed of 1847. A new system must require new safeguards, and to no one can the care of these be more properly entrusted than to railway managers.

As non-interference seems to us the best mode of legislating for railways, so railway managers seem to us to constitute the best and only safeguard against accident, and the only one on which no reliance has been placed. It cannot now be very well denied, that a railway accident, whosoever else it may affect, inflicts a certain, and nearly always a very heavy, loss upon the railway company, exposes the directors to very great odium, blame, and misrepresentation on the part of the public press, and subjects railway officers to the fear of losing their appointments. Pecuniary and moral responsibility of this kind is what our institutions teach us to rely upon in every other case, but the word "railway" has the magic power of shaking our convictions and our prejudices and banishing our common-sense. It is contended that railways are only to be treated by exceptional law, and this has only to be asserted to be allowed,—so much the worse.

To find out the means of avoiding accident is to find out a means of saving money, and this is a further inducement, which affects railway managers and no other parties. The time is not so far back when the engine-drivers on the newly-opened railways were ignorant, drunken, brutal, ill-conducted, and desperate barbarians from the coalpits of the north of England, who were extravagantly paid, and who were under no restraint. It is well known that having no fear of death, they have purposely risked accidents for the sake of the fun, as they esteemed it, whereby human life was perilled and property injured and wasted. Fines they paid by common contribution from their large wages,—criminal punishments had no terrors for those whom death and danger did not scare. As to dismissal, it was only a change of employment—perhaps at higher wages. The man who was dismissed from an old line went to a new one; and after having made the tour of England, accepted higher wages abroad. More enginemen were wanted than could be found, and, though wages were so high, respectable men could not be got to enlist themselves in a body the members of which were so desperate, the nature of which was then so hazardous, and which the legislature were called upon to brand with a special penal code.

Thus the lives of passengers and the property of the companies were fully and truly at the mercy of a set of desperadoes. This is language which is strange now, but which was that of the press only a few years ago. The companies exerted themselves, they gradually trained a better conducted body of men, and they have now engine-drivers more intelligent and more trustworthy, at very much less than the wages which they then paid. The saving to the companies under this head is very great; so is the consequent saving which they have been able to effect in the consumption of fuel and the wear and tear of the working stock. All this is over and above the greater freedom from accident.

It seems strange to look back and peruse the virulent attacks and abuse which were lavished on railway directors at the time of which we are speaking, and the *Times* did not forget to demand that directors should be made criminally responsible for the engine-drivers. We believe there was but a very narrow escape from a Draconian code, whereby railway directors, officers, and engine-drivers would have been left open to criminal pains and penalties. This is an *ultima ratio* for railway abuses which is a great favourite now, though how it would work it needs no great cleverness to foretell. The office of a railway director at the present moment is one of much more honour and vanity than emolument—sometimes nothing a year and a vote of censure being the salary, but most frequently the liberal sum of fifty or a hundred pounds a year; which latter is, we believe, the sum forming the civil list of a railway king.

The establishment of a body of gentlemen, who are not to be well paid nor to be greatly honoured, but who are to be marked out for the application of the most hateful criminal proceedings for acts and persons beyond their control, would be a novelty in English society. What class of persons would succeed members of the legislature as railway chairmen and directors, we do not pretend to say: we only know that the present class of directors would retire, and that a lower class would take their places. The nearest model we can get of the effect of such legislation is supplied by the newspaper press, wherein the wisdom of parliament has so hedged the proprietorship with criminal liabilities, that it is most rare for the real proprietor to be registered and published, and an ingenious deceit is practised which would do credit to China. In some provinces of that enlightened empire, substitutes are to be obtained for the price of seventeen pounds in hard money, who will undergo the penalty of death or the greatest tortures; and, in England, the Attorney-General is fain to content himself with a substitute, who, for a given consideration, will consent to be fined in the Exchequer, or sentenced to imprisonment in the Old Bailey. Instead of the class of newspaper proprietors being raised by the presence of Sir John Easthope, Bart. M.P., or John Walter, Esq. M.P., whose public character and responsibility might be brought publicly to bear, the legislature has effectually provided that public and personal standing shall be of no value, and a virtual protection shall be given to the libeller and scandal-monger, for whom under no circumstances has the law any terror, and whose calumnies now only have power, because personal character is allowed to be of no weight in the decision. The same results would attend the application of criminal responsibilities to railway directorship, and the least of all consequences of such ill-advised legislation would be the substitution of men of straw for men of character and responsibility.

What benefit has resulted from Board-of-Trade-inspection we do not know, and we are hardly aware that the inspectors put forward any very prominent claim. Indeed, so small is the appreciable benefit, that we apprehend the days of railway inspection are numbered, and that many years will not elapse before it becomes obsolete. We have an example of this in gas inspection. It is singular that the progress of the steam-packet, gas, and the locomotive engine, was impeded by explosions at an early date. The blowing-up of one of his first engines in Wales was the true cause why Trevithick's locomotive remained unused, and it was charged with the two faults of a dangerous construction and a want of bite, which in the present day do not present themselves as common objects of fear. The dangerous explosion of a locomotive is now one of the least-known causes of accident, and two cases only have, we believe, occurred of late years—one in the United States, and one on the Sheffield and Manchester Railway. The blowing-up of one of the first steamboats gave this mode of conveyance the character of great danger; and those who remember the defective construction of the boats which first ran on the Thames, can bear witness to their clumsiness and liability to derangement. Within two years of the establishment of a gas company in London, a gasometer blew up with a terrific explosion, and so much were the public alarmed at the seeming hazards of these magazines of dangerous combustible, that an act was passed, which is we believe still unrepealed, placing very great

restrictions on gas companies, and requiring them to comply with certain regulations and to undergo a government inspection, before they were allowed to open their works.

Whereas the Board of Trade now claim to be the inspecting department over public establishments, the Home Department was the one at that time to which the gas companies were subjected, and in conformity with the same predilections which now rule at Whitehall, a military officer was appointed as inspector-general. The first inspector-general of gas-works was the celebrated and ingenious Sir William Congreve, but, except as the means of giving large fees to the gallant general, the inspection, even in his hands, became quite a nullity, and we believe that since his death, no inspector-general of gas-works has been appointed; and at the present day, no one knows anything of the safeguard of gas inspection or places any faith in it, while the explosion of gasometers is so rare that it is not thought of.

If steamboats and gas-works are now able to do tolerably well without inspection, and are daily brought nearer to absolute safety, it may be expected, by cool-minded men, that in due time railways may likewise be able to do without inspection. As, too, so many public establishments have been formed and matured without public inspection, we can see nothing so peculiar in railway undertakings as to prevent them from advancing to perfection without government help.

At any rate, the present inspection is fruitless and unsatisfactory. The only person who has been able to find any kind of utility in it has been *Punch*, who says that when an accident takes place, and the public mind is in great alarm, General Pasley or Captain Coddington is sent down, and makes a report, complimenting everybody and everything, and showing that nobody is to blame; and thereupon the public terror is quieted. Certainly the inspectors' reports contain nothing else, and it would be vain to seek in them for any practical suggestion or any original contribution.

Whether this state of affairs is attributable to the employment of military engineers we do not allege, but, nevertheless, whatever value we may attach to our military brethren in their own department, we cannot, either *a priori* or from any acquaintance with their actions, place any faith in their civil capabilities. We very early pointed out the consequences of putting officers of the Royal Engineers in a false position, and pitting them in an unequal contest with the heads of the engineering profession here, who are acknowledged to be the greatest civil engineers in the world. Civil engineers have exercised the greatest forbearance under the insult to which they have been exposed, of the intrusion among them of incompetent persons; but opportunities have necessarily arisen, in which eminent men in this country have been compelled to express their contempt for the judgment and attainments of the government functionaries. General Pasley, who, among all the proceedings of the Board of Trade, has remained exempt from the suspicion of corrupt motives, and whose character as a highly honourable and well-intentioned man, secure for him personal respect, has lately, by an officious interposition on the subject of the Menai Bridge, laid himself open to the observation of Mr. Robert Stephenson, that he does not know anything about the plan, to which the General supposes he offers insurmountable objections.

One objection we made in the first instance to the appointment of government officials, was the impossibility of government paying an adequate salary to secure the services of individuals against the competition of private enterprise. Sir Charles Pasley being a general no one of course wants, and Mr. G. R. Porter is content to be promoted to Mr. Macgregor's place as joint secretary to the Board of Trade; but most of the other parties attached to the railway department have passed over to the side of the companies. The celebrated Mr. Samuel Laing, who concocted the whole system of aggression on railways, and who was the ambitious spirit of the Board of Trade, has for some time been a flourishing railway parliamentary counsel, and is the author of a pamphlet against the railway department. Captain O'Brien is a railway man; Sir Frederick Smith is still, we believe, chairman of the Belgian Eastern Junction Railway, and we think in directorship; Captain Coddington has accepted the managership of a railway. The time is perhaps not far distant, when the Railway Board being disbanded, the Right Honourable Edward Strutt, M.P., may succeed the Right Honourable George Hudson, M.P., in a chairmanship;—nay, who knows but in time, when he has seen a railway, and gets to know something as to what it is, the Right Honourable Sir Edward Ryan may be elected to a seat at some board? These things would not be more extraordinary than Mr. Laing writing pamphlets against the Board of Trade.

In the men of the Railway Board we have no confidence, and in their measures no more; and we are very little disposed to trust a progressive institution like railways to their mercies. In a new age we have got a new experience to learn, and we must have time to learn it. The only thing we have to fear is lest, by our prejudices and our ill-timed meddling, we keep back the benefits which are tendered for our enjoyment. We have kept back railways and we have kept back electric telegraphs, but we are still on the verge of enjoying a vast extension of the resources of science. This year the telegraph will speak with its lightning tongue to the ends of the land; the word which is said in London shall in the same time be known in the great cities of the island, and shall meet with its instant answer from beyond the utmost limits of the hearing or gaze of man. The electric telegraph will be claimed by the same despots as the railway; gentle dulness will find evils in the telegraph which demand its chastening care, and the concessions in railway inspection will be urged as a reason for placing our correspondence under the same inquisitorial regime.

The effects of the electric telegraph prudence forbids us to limit or assign, but it is evident a very great change must be produced in our habits and associations. Not only must the whole range of commercial transactions be affected, but even the operations of the law must be modified. It may be questioned whether, in the present state of jurisprudence, the beneficial use of the telegraph in arresting the course of criminals be not illegal, for it must often involve the absence of a writ or trespass on a jurisdiction. We leave it to the lawyers to determine what form of writ and what form of service they will adapt to the electric telegraph, in what manner a Master in Chancery in Southampton-buildings shall take the examination of a party at Liverpool, or how a Telegraph Affidavit Office is to be organised in Paper-buildings, Temple; but they are very likely to be called upon to provide for a new state of circumstances, caused by the revolutionary influence of the telegraph.

We cannot but think it fortunate in every respect that the monstrous Railway Bill of 1847 was not carried, for it would have greatly aggravated the difficulties which now beset railway enterprise. How it can have been brought forward in a country claiming to have a great school of political economy seems wonderful, still more so that it should have received the sanction of a department, which claims to be the scientific political department, and boasts of Huskisson, Lord Sydenham, Deacon Hume, Macgregor, and Porter. We know no greater slur on the political economy of this country than the series of railway bills, and we fear that it is to be attributed to the sacrifice of political principles to personal ambition. The foundation of political economy as applied to trade is the doctrine of non-interference, which is violated by every railway bill.

The provisions of the Janissary Bill of 1847 were intended to improve railway administration, and to prevent undue speculation: the result would have been to diminish directorial responsibility, and to favour the operations of stags. Of all provisions, that immediately affecting the surveys is the one, which coming in our own line, most interests us, and we are able to affirm that nothing could work worse. To require the deposit of 200*l.* a mile in addition to the other exactions would have the exact effect of injuring many good undertakings, of impeding all during times of commercial distress, and of promoting the views of the stags in times of speculation. The demand of any deposit as a security for the bona fide origination of an undertaking is a fallacy, which has nothing but the imagination of its inventors to give it countenance. It is evident that during any tightness of the money market the enforcement of a deposit must act as a strong check; but then it touches good undertakings as well as bad. In a time of speculation, whether the deposit be 5 per cent., 10 per cent., 50 per cent., or cent. per cent., it is perfectly immaterial, so far as the possibility of raising it is concerned, and the unfortunate experience of 1825, before the time of railway manias, proves this. It makes a great difference to the projectors how much they can get into their hands to spend, but it makes no difference to the speculators, who are imagined to furnish the deposit, as the deposit, in a financial point of view, is for the most part fictitious.

The famous deposits of 1845, which were used by the *Times* as such a bugbear, involved only a few changes of figures in the bankers' books, and it may be said that they never were in existence. Even of those sums which got into the hands of projectors, the whole was not wasted, for as they largely dabbled in scrip, and gambled with each other, so they in effect worked for scrip, which may be considered an ethereal medium.

An acquaintance with the circumstances of railway engineers, surveyors, solicitors, secretaries, and projectors, will fully convince the in-

quirer that whatever the supposed gains of these parties in 1845, their present possessions, taken generally, are very small; and the solution of this is, that their wealth in 1845 resolved itself into that proverbial bubble—scrip, the certificates of which, for that matter, they may still possess, but the imaginary value and premium of which they have lost for ever. Making allowances for scrip operations, the actual waste of capital in the gambling of 1845 was very small, and certainly very far below that of 1825, when so much capital was sunk abroad in worthless and unprofitable operations.

That some few engineers, lawyers, brokers, and capitalists have realised money is indisputable, but the number of these, and the gross amount of their acquisitions is very small, and the mass of speculators and operators have not realised anything.

What is the real amount of capital wasted or lost to the country in 1845, it is hard to calculate, but we do not believe it can anyhow be more than two millions, while perhaps it may be only one million—perhaps it may be that, comparatively speaking, it is nothing. In this country a great number of persons are always maintained in idleness, so that it does not make much difference if some of the funds of these classes are distributed for a time in making some of its members railway committeemen and surveyors, instead of keeping them, as they otherwise would be, cigar smoking, billiard playing, or fox-hunting.

If, moreover, we consider that a larger amount of real and effective labour was performed by the population of England in 1845 than in any previous year, and a larger amount added to the fixed capital and resources of the country, it becomes still more questionable whether on the balance of transactions the country was in anywise a loser by the gambling share transactions of 1845. We know that we are great gainers by the extension of the railway system.

For whatever purpose the leading organ of the world, the *Times* newspaper, is pleased to devote itself to a crusade against English railways, which it seems determined to injure *per fas aut nefas*, by any means, by any representations, by their merits and by their demerits, by truths and by falsehood. With an ignorant population, and with railway managers not overskilled in political lore, a subtle and unscrupulous adversary is able to represent every thing according to its own ends; and little more than good fortune, and some want of faith in the objects of the *Times*, has secured this country from being victimised into surrendering a most valuable institution to the clamour of a most audacious system of misrepresentation.

Without going back to the earlier efforts of the *Times*, it may be enough to signalise some of the later assertions of the *Times*. The charges against the railway system for its operations in 1847, include the following:—

- 1st. A large importation of foreign corn.
 - 2nd. An increased consumption of foreign luxuries during a time of severe privation, when greater saving was the more needful.
 - 3rd. A diminution in the stock of cotton and other raw materials of manufacture.
 - 4th. An increased use and higher price of iron at home and lessened consumption abroad.
 - 5th. Causing the stock of gold to be sent abroad.
 - 6th. Depriving government and the commercial interest of capital.
 - 7th. Depressing and ruining the manufacturing industry of the country.
- We believe this sample is such a one as the *Times* will accept, as not going beyond the bounds of its accusations.

There was in this year a very large importation of foreign corn, in consequence of the failure of last year's harvests. This failure could only be supplied by import from abroad, and has no connection with railways.

It is quite true that in 1847 there was an increased import of foreign sugar, meat, butter, cheese, and other provisions, but which has no connection with railways. Had there been no such increase it would have been duly noticed by the *Times*, and charged against Sir Robert Peel and Lord John Russell, as a failure of their tariff measures, which were purposely framed to increase the consumption of sugar and foreign provisions.

The diminution of the stock of cotton was owing to the failure of the cotton crop in the United States, and with a short crop there must be short stocks and high prices. All this has no connexion with railways.

There has been a greater demand for iron at home in consequence of a greater number of railways; but as these are very useful, we do not think this is any harm. A higher price of English iron in foreign markets is a necessary consequence. This charge has a connection with railways.

Gold was sent abroad to pay for foreign corn, and nothing else could be sent. Whatever the League partisans and currency theorists may persuade

themselves, gold must a ways be sent out to meet a sudden demand for gold. Mr. McCulloch showed this long ago. The failure of a harvest is a sudden and irregular event, requiring a sudden and irregular supply, which can only be settled immediately in gold, and not in goods, as the theorists expect. The farmer on the banks of the Mississippi or the Vistula will not lay in a stock of cotton or ironwares enough for four or five years' consumption, and take the hazard of fire, damp, and waste, let the goods be offered to him at any price however low. He will always prefer to take English goods as he wants them, and at the price of the day. The merchant of New York or Dantzic, though he may be tempted to a small extent by cheapness to increase his stocks, will not do so to the full extent required, because the risks are not worth the advantage. The English manufacturer and merchant will always be left to bear the risks of the stock, as he does now, while as a mercantile fact it is well known that from the greater wealth of England the stocks are in her hands. The gold therefore must go out, and it will come back, as the goods are ultimately taken in the final liquidation of the account. The gold always has come back and always will, while the goods instead of being sold at a depression are sold at more favourable prices.

It is a recognised expedient of the Bank of England, supported and inculcated by the highest authorities, to raise the rate of discount to a ruin pitch in the event of gold going out of the country, with the view to force goods abroad and prevent gold going. It is supposed that by causing sales here at ruinous prices, foreign merchants are induced to take goods instead of gold, and that thereby the gold is kept in the country. As, however, the larger stocks of English goods are always in English hands and not in foreign hands, no great increase of sales can take place, but only a depreciation in price. The goods offered in the market, however small, determine the price of the stocks, however large.

In the face of this admitted doctrine we assert that the effect of raising the rate of discount, or putting on the screw as it is called—

Does not cause goods to be sent abroad instead of gold.

Does not prevent gold from going out of the country.

What it does do is—

To cause severe distress at home.

To depreciate all our stocks of goods abroad.

Our deduction is—

That the screw does not effect the proposed end, that it does no good, and does great harm.

If no "screw" were applied, the country would suffer no possible harm; no more gold would go out without the "screw" than with the screw; but distress would not be produced at home, nor would our goods be disposed of at depressed prices abroad.

Although the "screw" principle has passed unquestioned, it has no single statistical fact, and no solid mercantile experience, to recommend it. It is quite groundless.

Railways did not deprive government and the commercial interest of capital. Government has got the capital it wants, and if it has to pay a higher price it is not on account of the competition of railway companies, but chiefly in consequence of the "screw" having been applied by the Bank of England. The commercial interest, on account of the depression, has required a smaller amount of capital, and there is no statistical foundation for the assertion of any interference on the part of railways. What has been wanting during this year has been confidence and not capital,—the want of confidence being greatly aggravated by the exertions of the *Times* newspaper.

The railways have not depressed or injured the manufacturing interest of the country in any way. They have not diminished the gross amount of capital; they have not interfered with the manufacturers' share; they have not diverted labour. The manufacturing interest has suffered from the famine, the want of raw material, depression of prices, and want of confidence: the two latter circumstances made much more oppressive by the "screw" and its votaries.

While the railway system has been falsely accused, it has had no acknowledgement of the vast good it has done. Putting aside the large addition made to the fixed capital and permanent resources of the country, the railway system has, during a year of grievous famine and great commercial distress, allowed an efficient scheme to be carried out for the employment of a large body of the population. If no railway works had been provided, the population of England would still have been fed; but in 1847 they would have been unemployed and discontented, and while their labour would have been lost to the country, there is no saying what would have been the political and social consequences; whereas in no year even

of prosperity has there been less political agitation than in 1847, when a general election is held, during which party feeling is almost extinct.

The experience of every fact confirms the truth of that theory which asserts that railways are not made with new capital or new labour, but by the increased energy of the labour of the country. This or something like it must be the truth, and it is neither inconsistent, nor improbable; no more so than the admitted fact, that while the ratio of agricultural labourers is diminishing, the extent of cultivation and production is increasing.

If new labourers and new food be not required for railway purposes, new capital cannot be required to the amount proposed, and the capital required can only be the small amount of ready money necessary for the temporary representation or "clearing" of the transactions.

This may appear very difficult of belief to those who conceive that every figure of £ s. d. put forward must be the representation of solid bullion; but it has nevertheless the guarantees of truth. The development of the machinery whereby a hundred million's worth of railways is produced in a year may elude analysis in our imperfect acquaintance with the true operations of currency, but it does not invalidate the conclusions. We may expect that as the machinery acquires perfection the operations will enlarge, and it is instructive to look back for a few years and to witness our present progress. In 1840 a return of railway calls, made by Mr. Earle Langston, a Manchester sharebroker, gave as the total for that year, £7,491,390. This sum, during the time of getting it in caused the greatest alarm, the calls in the first quarter of 1840 amounting to no less a sum than £2,166,090, and it was pronounced utterly impossible for the resources, capital, income, and surplus revenue of the country to produce any such sum. It was, however, produced.

In 1847 the amount of calls in some single weeks was as much as the whole yearly amount of 1840; and we are not aware, notwithstanding what the *Times* says, that the capital of the country is exhausted.

We cannot conceal the uneasiness with which we contemplate the prospects of the country in reference to railway operations, in consequence of recent operations and events. When the continuous period of depression arrives, and when it is most difficult to work the financial machinery, the construction of railways will have so far diminished, that the means of adequate employment and exercise for the working population will not be found. If, in consequence of this year's abundant harvest, and the fall in prices which will result, a period of speculation and share gambling should next year arise, it cannot now be directed towards railways, and will therefore, in all probability, take the only open field of foreign mining, which is under no such restrictions; and therefore the evil of 1825 may be renewed.

We will only say a few words by way of conclusion. "Let railways be free, and the less legislation and inspection the better for the country."

THE BRITISH MUSEUM.

No. II.

The dispersion of the Greek and Roman antiquities consequent upon the demolition of the old rooms, and the non-completion of the new ones, causes some confusion, and there is a difficulty in finding them; but this will soon be remedied. The arrangement is altogether so imperfect, that it leads us to remarks more discursive than they otherwise would be. It is, however, the temptation of a large collection like that of the British Museum, to present a great variety of objects to the gaze, and to excite at each moment some new thought, little dependent on those which have just gone before. This is the great medicinal power of such collections to a mind diseased or worn down; it is a quality of refreshing the jaded thoughts, of awakening new ones, of alluring the weary gaze, a temptation now to close and busy scrutiny, anon to sit down in quiet meditation. We may call such a place a *sanatorium* for the artist and man of taste, while it is the best place of exercise and refreshment for one in the full vigour of his powers. The Museum is however much less visited by architects and other artists than might be expected, though it is not neglected by the amateur. If we are to judge by their modes of acting, our English professors have strange ideas as to the cultivation of taste, for they seem to think that it will grow and feed, like some exotic plants, on air, or rather grow without feeding. How many men are to be found not wanting in means, who have neither library nor museum, who never read, and who never study works of art at home and abroad, but trust to the daily plodding of an office as their only school.

In going round the Museum, and seeing the number of unintelligent, nay even of brutalized and debauched countenances among the visitants, the question is naturally raised, "Can the Museum do such parties any good?" Take, for instance, those least capable of appreciating the immediate worth of the objects they see, who pass round, scarcely moved by the wonders about them—the observer will not deny that even they feel a beneficial influence. Novelty or strangeness will always operate upon every mind to awaken it to some extent, and it is a great object to effect this in those minds which are most brutalised: to awaken attention is to cultivate the first quality of the mind, and to lay the way for its further exercise.

It is scarcely possible to look at any department of the Museum, without finding some useful example, even if wandering amid the chaos now reigning. Who, for instance, can look at the collection of tombs and urns, without seeing the great superiority of the Romans in all artistic exercises over ourselves? An English churchyard is a set of stereotyped stone or wooden tablets, sometimes varied by a pile of monstrous ugliness. One head-stone is like another, except in as far as it is necessary to inscribe it to John Thomas, instead of Thomas Johns; for, could the inscriptions be interchanged, the spectators of the head-stones would be none the wiser which is which. The cemetery system has in some degree broken in upon this monotony, and created a greater variety of forms; but still they are limited, and confined, as we may say, to sets. The mourner may purchase a No. 1 obelisk, or a No. 3 urn, as he would select a knife from a Sheffield pattern-card, or a printed muslin from a numbered specimen. A large lot of number ones and number threes is manufactured and worked up; for as to individuality of design, it is out of the question. It is not asked for, and the tomb-makers are guided accordingly. Any one who goes into a tomb-yard either in the New-Road or elsewhere, will find that the tradesman has an urn, an obelisk, a cross, a sarcophagus, a broken pillar, an altar-tomb, a coffin-tomb, and one of each of the recognised patterns.

In looking at the Roman urns in the Museum, and which being for one general purpose, are in some degree restricted in form, it is notwithstanding exceedingly pleasing to notice the great variety of design. It would be hard to find an English grave-yard which, with a greater number of tombs, could show such a pleasing application of artistic taste. Limited as to size, which goes little beyond a foot or fifteen inches cube, the Romans have made the most of their small material. The block of marble, alabaster, or stone, is carved into various forms. Some are perfect vases, one is a circular temple, another a fragment of a column; this is a square block decorated with a simple festoon, another has a façade with pilasters *in antis*; again, the proportions being those of a double cube, a raised oblong with festoon and tablet is flanked by torches at the corners; on some, the deceased is represented in various attitudes. The form and decorations vary in each example.

The Roman urns must have been wrought at little expense of material and little cost for workmanship, and yet very pleasing works are produced: while with us, great material and lavish workmanship are unattended with artistic effort. The same degree of labour which with us is bestowed on the mason's work, would suffice for that of the carver. While we acknowledge the artistic qualities of the Roman examples, their design is not always the most fitting, and it is very rarely applicable for modern purposes; some of the emblems are suitable only to Roman associations, while some seem to have no significance. Other designs are, however, pleasing. An urn, which is not numbered, has two very sharply cut medallion half-lengths of husband and wife; others have high relief busts of the deceased, or of a married pair. Again, the deceased is sometimes represented reclining on a couch in such an attitude half-raised as to allow the likeness to be given. We, who like cabinet pictures and cabinet works of art, might imitate this.

We have long thought that the establishment among us of public graveyards and cemeteries is well calculated to promote the application of art to memorials of the dead, and though we have noticed above our present deficiencies, yet we are quite ready to acknowledge the great improvement which has taken place of late years. We believe the chief obstacle now is the want of proper workmen, for the execution of a common design of foliage or flowers is still expensive. The Schools of Design are partly remedying this, by supplying better trained men; but the demand is still great, and the remuneration is too great for a class of labour which cannot be valued much higher than mechanical labour. Had the prejudices of the academicians been complied with in the establishment of the School of Design at Somerset House, and the declaration enforced, we should have been worse off than we are now. A declaration that a student in a school of design would not become a history painter or sculptor, portrait painter, animal painter, landscape or flower

painter, whatever supposed monopoly it would have given to professional artists, would have deprived the public of workmen, instructed to execute at a cheap rate common carvings and decorations. Whatever the sculptor academician may arrogate to himself as his province, he does not undertake a cheap tomb-stone or chimney-piece; and there is therefore no reason why the public are to have no choice between a costly work of art, and a work without any art at all.

It will be one result of the establishment of a body of cheap workmen in art, that the man of taste will be able to suggest his own design; and thus there will be a greater application of intellect and taste than can be contributed by the artists alone. Hitherto we have been dependent for our applied taste on the body of artists, and we can expect no greater progress than we have made with such a body, which is little in comparison with what might be effected by the co-operation of the great mass of the educated community. To arrive at this will be to arrive at a new era in art, and it will likewise supply a great defect in our artistical economy as it now stands; it will bring to bear that refined scholarship and education, in which our artists almost without exception are lamentably deficient. How few artists in the present day are able to take their stand as scholars and men of learning by the side of Michael Angelo and Leonardo da Vinci, to say nothing of artistical proficiency?

There is a strong call for the home application of art among us, but this can never take place until it ceases to be an extravagant luxury, and becomes an accessible pleasure. If a gentleman of scholarly tastes and refined education have the disposition to suggest the decorations and furniture of his house, he has not the pecuniary means of accomplishing it. He must at high rates choose furniture as cabinet-makers choose to give it, chimney pieces made by machinery, wood carving from the patent process, statues in terracotta, mouldings in cannabic, papier maché, or leather; everything on the stereotype plan, and yet at prices for which he should be able to have something original.

What could be more pleasing to one of good taste than to have, from his own suggestions or designs, and at a moderate price little above that of mechanical or ready-made articles, the furniture of a room, the chimney pieces, fire-grates, carpeting, and decorations made in harmony with his own habits, associations, and sympathies, the events of his life, the feeling of his home circle, or the traditions of his family? One who has the power may just as well have for emblem and design his own armorial bearings, his own loved flowers, or even favourite objects, as be dependent on the good graces of the manufacturer, whose object is perhaps to sink individuality for generality. Wherever gentlemen, even under present circumstances, have the means, a preference is always shown to individualise themselves. It is much more agreeable to go into a room in which the decorations are so formed than where they have no relevance. If family crests and badges are introduced in a cornice, or animals or flowers are adopted in ornament which recall perhaps some distant climate where honour has been achieved or wealth attained, there are ideas communicated to the mind beyond even the pleasure from well designed and well executed artistical productions, and the mind likes what is most practical, most individual, and most human.

Pursuing the train of these reflections, we have little doubt, and with the evidence there is, we ought perhaps to say no doubt, that it was the co-operation of all intelligent minds which among the Greeks and Romans gave a catholic impulse and progression to art. The suggestions of a Pericles must have been of value to Phidias; the inspiration of Michael Angelo was refreshed by his associations with the learned of his day; the companionship of Johnson and Goldsmith had its charm on the works and writings of Sir Joshua; and we believe that the energies of Barry may be upheld by his co-partnership with those who are most eminent in scholarship, most refined in taste, and most illustrious in political action. Looking at our group of tombs it is not displeasing to imagine that sometimes the design was prompted by the mourner, or was a tribute to the feelings of the deceased; that there was something higher than the compliance with a form of society, or the self-satisfaction of paying a last debt, and accepting a free discharge from all further claims on sympathy or remembrance. If the ready wit of the carver sometimes prompted the design, we may allow that quite as often the hallowed feelings attendant upon affliction and death may have influenced the inspiration; at any rate, on looking around us we cannot recognise our English church-yard characteristic—"To headstone as per pattern."

Among the urns is a small one to which we should like to refer, but which is now unnumbered. It is a square block, has a bas-relief of a husband and wife, each a half length in profile, looking at the other. The design of the

comb in the wife's head is worthy of notice, it is in shape something like the crest of a helmet. The execution of these figures is good.

No. 12 is a sepulchral vase or bowl of alabaster uninscribed, which is elegantly covered with foliage. It was found in a tomb near Naples.

No. 22 is a square block with a carved top. One face of the square is carved, and bears a tablet surrounded with ivy foliage, freely designed. It is dedicated to Claudia Fortunata, by her husband, and was at one time in Sir Hans Sloane's collection. As these urns were for holding the ashes of the dead, they mostly have a top, which in the case of cubic blocks, is designed like a pediment with returned ends.

A tablet to Cornelia Servanda (13) has a female figure in relief sitting or lying on a couch, so that her face is shown. On each side of the couch is a larger sized medallion, half length. The size of the tablet is about 18 inches by 16. This small space is well filled by the several parts of the design, and is much more pleasing than the tablets usually seen on our church walls, and having more surface than work.

Letter-cutting seems to be the chief art in tomb-making here, and even in this mechanical pursuit we have not gone beyond the ancients. Most of the Greek votive inscriptions in the Elgin room are by professed letter-cutters, and are remarkable for their sharpness, neatness, and regularity. The lines are straight and equidistant, the characters uniformly cut and placed in exact accordance with each other. On the Roman tombs the inscriptions are often cut by the workmen, and are not so regular.

No. 11 is an urn of a flat square altar-shape. It is dedicated to Julia Attica, and was formerly in the Burioni Villa. The composition is very pleasing, though the details are inappropriate. The top forms as usual a pediment.

No. 27 is a square altar-shaped urn, dedicated by Marcus Junius Hamillus to himself and his wife, Junia Pieris. The size is about a foot cube. The composition represents a pediment supported by two pilasters, and is, like some others, of an architectural character. The pilasters are filled in with foliage. Within these there is an oblong tablet bearing the inscription, and supported by two griffins. Underneath the tablet, and between the griffins, is a wreath surrounding a medallion.

The urn of Pompeius Justinanus (No. 7), is original. It may be called a slice of a cylinder fluted, and having in front a large tablet with dented ends. The labour on this is not much, but it is recommended by the singularity of the design.

No. 4 is dedicated to Vernasia Cyclas, the wife of a man of liberal rank. This is one cube placed on the top of another, with a pediment cover. The composition shows much variety of detail. The pediment is supported by two jointed torches flaming, and which rest on lions' claws. The upper part of the space within is occupied by the tablet, which is inscribed. Hanging over this is a festoon of flowers, the ends of which fall down nearly to the bottom of the composition. Below the tablet is a doorway with a pediment; within are the figures of the husband and wife in high relief. The whole rests on a moulded base, but which is perhaps modern.

No. 18 was presented, in 1837, by Mr. Mackinnon, M.P. It is dedicated to Tiberius Claudius Lupercus, a freedman. It is a square block with a pediment top. Within the front of the pediment are two birds pecking at a vase. The corners of the cover have a honeysuckle ornament. The face below is filled with an inscription within an oak leaf wreath, which is held up on each side by a winged genius, forming likewise a support to the corner. The plinth is moulded, but is modern.

No. 1 is remarkable for being solid and without any inscription, and therefore it can never have been used. It is a square block, having on its front a bas-relief of a figure leaning on a couch and offering a fillet or wreath to a boy. This is said to represent a funeral feast. This unfinished urn was likewise presented by Mr. Mackinnon.

No. 8 is a square block dedicated to Titus Titulenus Isauricus, formerly in the Mattei collection. It has on its front a relief of a figure reclining on a couch, and below it an inscription. The pediment is enriched.

No. 23 is a square block urn, with a plain pediment top. In this case, there is no artistic decoration, and the simple inscription is the only matter of interest about it, for the means of him who raised it were most likely less than his affection. The inscription, which is in large letters covering the front, is—"To Lucretia, who lived xii years and viii months. Her father raised this to her manes."

No. 36 is an urn dedicated to Decius Albiccius Cilicinus. It is a flat cubic block, with a high pediment top, which is enriched with a vase at which two ravens are pecking: they are freely carved. Below is a tablet

with a masque of Bacchus on each side, from which a festoon falls, amid which are other ravens.

No. 17 is dedicated to Cossutia Prima, and was found, in 1788, in the grounds belonging to the Villa Maroni, near Rome. It is a cube and a half without a top. At each corner is a pilaster, filled in with foliage. Within is a large tablet, surrounded at the top and sides by rich foliage, or what is called arabesque. Below is a Cupid in a car driving four horses, perhaps those of the Sun. The whole is very pleasing. The sides of the urn are ornamented with pine-trees.

No. 32 is a vase of a broad oval form. On the front is a small tablet. On each side is a stork, between which, twining around their beaks, is a serpent. On the back are two storks drinking out of a vase. There are other enrichments. The urn was discovered in what is called the *Ager Romanus*, in the neighbourhood of Rome. It is remarkable as being dedicated to Pompey Locusto, aged 65, Attilia Clodia, his wife, aged 60, and Pompey Locusto, their son, aged 21, who all died of poison in one day.

The introduction of the stork in this monument suggests how frequently and appropriately it might be used in our tombs, as the emblem of filial piety, while the fabled pelican may be made to represent maternal piety.

While speaking of the urns, we cannot but regret the destruction of the No. V. Room of the Townley Gallery, which was fitted up with niches like a Roman family vault. The niche was called a *columbarium*. One sepulchre near Rome, that of the dependents of Livia, the wife of Augustus, broken open in 1726, contained at least 200 urns. Fabricius asserts that the freedmen formed themselves into guilds for building these tombs at a joint expense, the niches being appropriated by lot, or otherwise. Perhaps there were speculators among the Romans who sold niches to the lower classes, in the manner of grave-yard trading in London.

No. 6 is a specimen of an *olla* or round urn of earthenware. One is dedicated to Anniolena Servilia. The *olla* were used for persons of the lower classes, freedmen, and slaves, and were sunk in the wall, within an arch, the lids only being visible. An inscription was put in front.

On the urn No. 13, a family are represented mourning over a dead female. Under the couch are her sandals and a dog.

No. 14 is an urn formed as a round temple. The cornice is upheld by three Termini and by six Ionic pilasters. The whole decorated with festoons. It is dedicated to Serullia Zosimenes.

No. 15 is not remarkable for its subject, but as having been engraved so long back as 1598 in Boissard's "*Antiquitates Romanæ*."

No. 21 is not Roman, but Etruscan. It is of baked clay, with a bas-relief representing, it is said, Echellus fighting for the Greeks with a ploughshare at the battle of Marathon. The top has a leaning female figure, lying on a pillow. This is rudely executed, and has an Etruscan inscription undeciphered.

No. 25, a plain urn or vase, dedicated to Flavia Valentina, still contains the ashes of the female to whom it is inscribed, and was found, in 1772, on the Latin Way, two miles from the Gate of the Lateran at Rome.

Many of the urns are brought from the immediate neighbourhood of Rome, and are, therefore, specimens of the metropolitan workmanship. They are, however, chiefly of late date. The locality of No. 4 is not stated, but from its being dedicated to the wife of a *Scriba Cubicularis*, it is most probably Roman. In Gruter's time it was in a collection at Rome. There has been some discussion, by the bye, as to the letters F. A. P. on this monument. They are, perhaps, the carver's initials. No. 17 was found, as already stated, near Rome. Nos. 20, 31, and 38, were found in the Villa Pelluchi, near the Pincian Gate at Rome. No. 26 was found at Rome. No. 30 seems to be Roman. No. 32 is already described as Roman.

Some of the urns are Neapolitan, as Nos. 12 and 29, from Sir William Hamilton's collection.

Besides the urns are Roman *cippi*, in the form of a low square or round column, or rather portion of a column. They resemble altars in form, and were used for other purposes besides monuments. There are many inscribed sepulchral *cippi* in the British Museum, the designs of which are equally worthy of attention with the urns.

Though we have alluded to Etruscan tombs, we shall not here give any description. The collections of funeral monuments in the Museum are large. The Roman have been already extensively described; the Etruscan are no less interesting. The Lycian tombs in the new rooms are on a large scale. Many of the Egyptian relics are of a monumental character; and the Etruscan paintings in the upper rooms are likewise from tombs. There are various specimens of Greek monuments.

It is much to be regretted that the collection of Roman busts is not

larger, for a series of this kind is very interesting from its practical and individual character. Such an assemblage as that in the Louvre, the Vatican, and other continental galleries, awakens very agreeable emotions. The countenances are truthful and life-like, while there is an independent interest in the historical associations they suggest. Thus there is a double influence of art and liberal study, which is well worthy of cultivation. Whoever compares the two, will find far less attraction in the most beautiful busts of the ideal—even in the Apollo, Venus, or Diana—than in the company of a few plain Romans. There is generally a steadiness and solidity in Roman features, which is agreeable to an English spectator; he seems at home among a people who have been dead for fourteen hundred years, and under the influence of the conformability of character he recognises little difference of race. Strange as it may seem, a gallery of Romans is not un-English, and is much less strange than a gallery of ancient Greeks or modern Frenchmen. We should, therefore, much like to see the series of heads and busts in the Museum extended, even by the addition of copies, which can be readily obtained, as so many busts of Roman emperors and public characters have been found.

When put in comparison with portrait heads, the ideal busts of gods and heroes are tame, and they suggest strong doubts as to the soundness of idealization in art. This is to be accounted for on simple principles: in nature there is nothing without its beauty, so there is nothing without its defect; still less is there to be found the unalloyed preponderance of any quality, for the balance is always kept up. It may be said that the idealization of a Jupiter or a Venus in which imperfection is not to be found, is therefore beyond humanity and godlike; but as the mind of man has a greater sympathy for manly attributes than for godlike qualities, of which it knows nothing, so whatever praise may be awarded to the ideal, it is disenchanted by reference to the natural, and a higher idea is communicated by the latter than by the former.

In the Museum, the busts are, for the present, arranged in groups on shelves. Thus we have a group of gods, of heroes, of emperors, and of empresses. We recommend the visitor to compare Minerva, Bacchus, Apollo, Diana, and Juno with Julius Cæsar, Hadrian, Nero, and Severus, or even with Otacilla, Sabina, Faustina, Domitia, and Olympia.

We believe a greater development of the department of portrait busts would be found useful in its influence on the public mind, being congenial with the English character. It is much to be regretted that in the metropolis there is not as yet any large collection of ancient or modern busts, though the Palace at Westminster promises in some degree to supply the loss of the latter. This Palace will give us the example of an historical gallery, of which the French have a specimen at Versailles, and the Bavarians at Munich. A zealous chief commissioner of the Woods and Forests might cheaply distinguish himself by collecting together the portraits and historical pictures in the royal palaces and national museums, and laying the foundation of an historical gallery. It is true we have fragmentary collections now, as that of portraits in the British Museum in the Natural History Rooms, and of marine pictures at Greenwich. It might, perhaps, be worth the while of the British Institution, or some other artistic body to get up an exhibition of historical works of art. The Society of British Artists is ambitious of distinction—it may take advantage of the hint.

The British Museum collection of heads, although small, has many of interest. In the Greek series are two attributed to Homer and Pindar. No. 42 is Periander, a tyrant of Corinth, one of the seven sages, who lived about 2470 years ago. It may be questioned whether this is a likeness. No. 26 is the tragedian Sophocles, the contemporary of Pericles, Thucydides, Phidias, Eschylus, and Euripides. No. 32 is Pericles, and these two busts bring us in association with the illustrious men of twenty-three centuries ago. It is to be noted that Pericles wears a helmet, which Plutarch says was adopted by the sculptors to conceal the bad proportions of his head, which was likened in shape to that of an onion. No. 20 is thought to be Hippocrates, the physician. It is from Albano, from what are thought to be the remains of the collection of M. Varro, who says Pliny collected seven hundred portraits of eminent men. No. 28 gives us Diogenes, the cynic, the contemporary of Alexander the Great; and No. 38 is another, the great orator Demosthenes. No. 34 is the philosopher Epicurus, the head of a sect. No. 3, Room XII., is the head of Aratus, a poet and philosopher, and bears the name of Eraclite. Sophocles, Pericles, Demosthenes, and Epicurus are Athenians. Whoever views this collection cannot but regret that it is not larger, that we might become more familiar with the countenances of the favoured heroes of our boyhood. We think it would be no unfitting compliment to the memory of

an eminent promoter of art, to place the bust of Pericles in the Elgin collection, the chief beauties of which were created under his patronage, for Phidias could not have wrought but under the treasurership of Pericles.

The Roman heads are happily more numerous, but far from enough to satisfy curiosity. No. 51 is Augustus, a Napoleonic countenance. No. 53 is an original bust of Marcellus, the favourite nephew of Augustus, dedicated by the body of Decemvirs. Tiberius Cæsar follows Augustus in time. No. 65 is Messalina, one of the wives of Claudius, and the most infamous woman of her day. The fashion of her hair is worthy of notice, as indeed is that of most of the empresses. Some of the modes of head-dress are far from inelegant, while others are quite as peculiar as anything modern, as for instance those of Sabina and Domitia. At any rate, a Roman collection is one of the last places in which any support can be got for the doctrine of classicality in busts. The Romans were quite content to be featured according to the fashion of the day—the women in particular; while the greatest fear of a modern sculptor is to pay any such homage to the costume of his time.

No. 44, Nero, pins attention. His low forehead, marked eyes and nose, and large lower jaw, countenance the unfavourable accounts of his character, and we confirm our prejudices and dislikes, as most probably the Romans did, by looking at the likeness of the man.

No. 13 is the glutton Vitellius. No. 1, Room IV., is Trajan, a very business-like looking man, with a forehead not over large. Of Hadrian there are two busts.

No. 58 is Julia Sabina, niece of Trajan and wife of Hadrian, a matronly lady with her hair plaited and netted, as already mentioned, in rather a peculiar manner. No. 18 is Antinous, the notorious favourite of Hadrian. No. 43 is Ælius Cæsar. No. 11 is the illustrious Antoninus Pius. As we have noted of the hair of the ladies, so may we of the other sex. There is much variety in the mode of wearing it, which often approaches the modern style. No. 6, Room IV., is Marcus Aurelius, another philosophic emperor. He is dressed as a Frater Arvalis, a priestly officer. No. 32, Annia Faustina, is his wife. Her hair is worn quite plain, simply parted. No. 7 is Lucius Verus.

No. 29 is Severus, one of the emperors who visited Britain, where he died at York. No. 51, Room VI., is Caracalla, a fitting companion head to that of Nero. No. 39, his wife, Plantilla, has a fanciful mode of wearing her hair, but one not ungraceful. No. 85 is the elder Gordianus. No. 51, Room XI., is that of a Roman lady of rank, whose head-dress is remarkable and rich. As the lady is not known, it is most valuable as an illustration of costume. No. 54, the bust of a little girl, shows one of the fashions of wearing the hair, made up into little plaits and tied in a top-knot.

(To be continued.)

PHOTOGRAPHIC MANIPULATIONS.

The great beauty of photographic pictures and the varied uses to which the art of photography may be applied, invest this wonderful discovery of modern science with surpassing interest, and to the successful operator it possesses great fascination. As the manipulations, however, are numerous, and require great care—for a defect in a single one may prevent any results from being obtained—the art has not yet been so extensively practised as it deserves to be, and as we have little doubt it will be ere long. Many have been prevented from commencing by the difficulties which encompass the process, and many, after making the attempt, have abandoned it in despair of being able to succeed. These obstacles are in a great measure owing to the want of clear and satisfactory directions for conducting the various manipulations, and though it is extremely difficult to describe the processes of an art requiring so much nicety so as to insure success, we will endeavour to give such directions that we trust will enable most persons, by a little practice, to produce good photographic pictures. We are the more induced to hope that we shall succeed in this attempt, from having worked out the problem with such imperfect light only as the printed directions afford, and having experienced by many failures the points wherein such directions are vague and imperfect.*

* The most comprehensive work on the subject that we have seen is "Photogenic Manipulation," published by Messrs. Knight and Sons, which within a small compass treats of most of the varied photographic processes, but it falls in many points as a guide to the uninitiated.

Since the original discoveries of the means of fixing the images of the camera obscura, by M. Daguerre and Mr. Talbot, many variations in the processes have been discovered, but we shall confine ourselves to the description of the Daguerreotype and Calotype, which have hitherto been unrivalled in practice by any. The distinguishing characteristics of the inventions of M. Daguerre and of Mr. Talbot are, that in the former the image is impressed on a metal plate, and is subsequently rendered visible by the vapour of mercury; whilst in the Calotype process the picture is produced directly on paper, by the influence of the rays of light on the salts of silver. We propose in the first place to describe the manipulations of the Daguerreotype.

The apparatus essential to the Daguerreotype artist, in addition to the silvered plates, consists of the following articles: an achromatic camera obscura fitted with appropriate slides for holding the plates, iodine and bromine boxes, a mercury-box, three or more "buffs," and a spirit lamp with stand for holding the plates. The chemical and other materials are iodine, bromine, spirits of wine, mercury, cotton wool, tripoli powder, rouge or "finishing powder," and nitric acid.

The plates are now so well finished in the manufacture that with new plates comparatively little preparation is required. There are two kinds sold by philosophical apparatus makers, the one French, and the other English; the former of which are cheaper, but the plating of silver being much thinner, it is advisable for beginners to pay the higher price, as in the course of cleaning the plates after failures, they soon come to the copper, and the plate is then useless. In order to clean the plate it must be placed on a holder of some kind, to keep it firm when rubbed. For small plates a piece of wood, nearly the same size, will answer very well, the plate being held by the edges. Then take a small piece of prepared cotton wool, freed from all grease and dirt, which form into a ball, and dip it into a mixture of tripoli powder and of nitric acid diluted with one fifteenth part of water; a few drops of the mixture will be sufficient. In rubbing the plates, it is usual to direct that the cotton wool should be moved in a circular direction, forming circles on the plate of different sizes; but we believe the most successful artists polish their plates by a motion directly across. In giving the last polish, indeed, it is essential that the motion should be in lines across the plate, otherwise it would look misty when held in the direction in which the picture is to be viewed. This effect is owing to the minute scratches which will remain even after the most careful polishing, but when the plate is looked at transversely to the lines of the scratches they are invisible, and a black mirror-surface is presented. After rubbing with cotton wool and tripoli, take some fresh cotton wool, and rub till a bright polish is obtained. The finishing polish is given with the "buffs," which are pieces of wood covered with well washed cotton velvet. Some finishing powder, consisting of lamp-black and rouge, is dusted over the first buff, and the plate is rubbed along it briskly, taking care that the fingers do not touch. This operation is repeated on two or three other clean buffs, in order to remove the slightest trace of grease. When the polishing is finished, the plate should have a fine black mirror-surface, when held in the direction in which the picture is to be looked at. If the plate after use becomes scratched, it will be requisite to apply some fine emery powder and oil with cotton wool before applying the tripoli. In case any drop of mercury should adhere to the silvered surface, the plate should be heated by holding it over the spirit lamp with a pair of pliers until the mercury is evaporated. Some operators, always heat the plates, for the purpose of expelling greasy particles. It cannot indeed be too strongly impressed on the Daguerreotype artist, that the perfection of his pictures will depend in a great measure on the cleanness of the plates.

The next operation is to coat the plate with iodine. The iodine must be scattered evenly over the bottom of the iodine-box, and the plate exposed on its frame with its silvered surface downwards. In about half a minute the silver will become a gold colour, in consequence of the vapour of the iodine having entered into combination with it, and formed an iodide of silver. The length of time requisite for exposure to the iodine depends much on the temperature. At about 70° Fahrenheit, 30 seconds will be sufficient for a small plate, but it must remain till it acquires a golden tint, distinct from the brassy hue it at first assumes. If it remain longer, the colour changes to pink and to lead colour; in which case the plate must be polished afresh, and the operation renewed. The light need not be excluded during the iodising process, but the plate should only be exposed to its action instantaneously. The iodised plate might now be put in the camera, and in the course of five minutes, in a very bright light, a perfect picture would be obtained after exposure to the vapour of mercury. It

was in this mode that M. Daguerre operated; for in his original invention iodine alone was used. The inconvenience of so long an exposure to light, however, especially in taking portraits, was seriously felt, and after many investigations for the purpose of quickening the process, it was discovered that bromine in addition to the iodine would act with great efficacy as an accelerator; and now Daguerreotype pictures are by this means sometimes taken in less than a single second.

In submitting the iodised plate to the action of bromine the greatest care is required; for if the bromine be deficient, the plate will not be sufficiently sensitive, and if the bromine be in excess, the picture will either not be formed, or the plate will be covered with a mist. The simplest way of operating is with the common bromine pan, which is a shallow flat-bottomed vessel, with a cover of glass, ground tight to the edges, to keep in the suffocating vapour. A ledge inside the vessel holds a support, usually made of slate, for the plate to rest on with its silvered side downwards. It is most desirable to ascertain accurately the strength of the bromine water, and to have it uniform in all operations; a close approximation to uniformity may be obtained by mixing a given measure of distilled or rain water with saturated bromine water. The saturated bromine water is easily procured by pouring some bromine into a stoppered bottle of water, taking care that there is more bromine than the water will dissolve. A convenient solution for use is 40 parts of water to 1 of the saturated solution, which will then be of the colour of pale sherry. As much of this diluted solution must be poured into the bromine pan as will cover the bottom, and then introduce the iodised plate. If the plate has been well iodised, the vapour of bromine will impart a rose tint to it in about thirty seconds or less; but it is safer to remove the plate before it has received as much bromine as will give extreme sensitiveness rather than run the risk of giving it an excess. The plate is usually returned to the iodine-box for a few seconds, but this is not absolutely necessary. It must be observed that in the process of bromining, the length of time required will depend in a great measure on the iodising. A plate that has but a pale gold tint will require less bromine than one that has become of a darker colour. The tone of the picture is much improved by adding about 50 drops of muriatic acid to each ounce measure of the saturated bromine. A preparation of bromine has lately been made, called "accelerating powder," which is very convenient in use, and produces a pleasing tone of colour. It has also the advantage of greater certainty, if a fresh quantity of the powder be used each time; for this, as well as the bromine water becomes rapidly weaker by exposure, therefore it is advisable for beginners to renew the accelerating mixture each time of using. When experience has been gained, it will be sufficient to add a few drops of the saturated bromine till the water attains the proper colour. Care must be taken to exclude the light of day from impinging on the plate after it has received the sensitive coating, and it must be viewed only by the light admitted through the chink of a door or of a window shutter. The necessity for this precaution will be evident on considering that the rays of light which are sufficient to produce an impression in the camera in a few seconds are admitted through but one small aperture, and that when a plate is exposed to the light it receives rays from all surrounding objects.

When the plate is properly prepared and enclosed in the sliding case which accompanies the photographic camera, we have arrived at that part of the operation which requires the most judgment and experience—the exposure to the influence of light. The first things to be done are to select the point of view, and to adjust the focus of the lenses so as to obtain a distinct image with sharp outlines on the trial screen of ground glass. If the object to be taken be a building or a view, no directions need be given, as the judgment of the artist will guide him; but in taking a portrait much attention to minute particulars will be requisite to bring out a satisfactory result. The following general directions will be found useful aids in the endeavour. Care must be taken that no dark shadows fall on one side of the face, as they will be exaggerated in the Daguerreotype likeness and give great sternness to the expression. To avoid this, it is almost indispensable to operate in the open air. The camera should be elevated to the level of the face, in order to obtain the greatest perfection in the delineation of the features. The dress should not expose any large surface of white, for those parts would be solarised before other parts have had sufficient light; therefore it is usual, when collars or shirt-fronts appear, to cover them with black, which is withdrawn when half the time of intended exposure to light has elapsed. When the sitter has large overhanging eyebrows, it is extremely difficult to prevent the eyes from being thrown in shade, which gives a fearfully disagreeable expression; it is best in those cases to take the likeness *en profile*. The background should be sufficiently

light to throw out the figure and face without being too bright; but this is a point that the judgment and taste of the operator will determine, bearing in mind that the red rays make little more impression on the plate than black, and that the brightness of yellow and orange is also greatly diminished. Another point which it will be advisable to attend to is the personal appearance of the sitter. If a child, or a handsome young person, be the object, the focus should be as accurate as possible; but for those advanced in age, or who have defects on the skin, it is advisable to adjust the focus of the lenses so as to obscure those defects by blending the rays of light. There are many other minor points that will require attention, but taste and experience will guide the artist to perfection in such details; and the general directions here given will be found sufficient for most occasions.

When everything is properly adjusted, the case which contains the prepared plate must be substituted for the screen of ground glass, and the slide that exposes the plate to the image must be drawn up, taking care not to shake the camera so as to alter its position. The instant that the light impinges on the plate an effect is produced on the sensitive iodine coating; and it is the most critical point of the whole process to determine how long the action of light should continue. As there is no visible impression made on the plate by the rays of light, to guide the operator, he can only judge by experience—after numerous failures and a few successful efforts—when the light should be excluded. To aid in gaining this experience, however, some general directions may lessen the number of failures.

We will suppose the artist to have prepared plates in a uniform manner, and of such a degree of sensitiveness, that they will take a building on which the sun is shining in three seconds. When the sun is obscured, the plate will require six, eight, ten, twenty, or thirty seconds to sufficiently receive the impressions of the ray from the same object, according as the clouds are rarer or more dense. As so much, therefore, depends on the state of the atmosphere, and as a second more or less will effect a much greater change when the sky is bright than when it is obscured, it is always much better, especially for tyros in the art, to operate on a gloomy day, for then the error of a few seconds will not much impair the effect; taking care to give, under such circumstances, what is considered rather an excess of light. In taking the largest-sized view that the camera will admit, a diaphragm is used to confine the rays to the centre of the glass, for the purpose of avoiding the effects of aberration; and as the diaphragm greatly diminishes the quantity of light, it will be necessary to make allowance in the time of exposure in proportion to the covered surface of the object-glass. For portraits, it is desirable of course to diminish the time of sitting to the least possible quantity, and some portraits have been taken in the fraction of a second, but the chances of success under such circumstances are greatly diminished. It is hazardous, therefore, to attempt to operate in so bright a light, and the effect is not nearly so pleasing, even when successful, as when the portrait is taken under a more sombre influence. We have been most successful when operating in the open air, about six o'clock on a summer's evening, with the sun obscured by light clouds, allowing the plate about twenty-five seconds exposure to the light in the camera, which is one of Mr. Ross's manufacture, with double lenses and $1\frac{1}{4}$ -inch aperture. When portraits are taken in a room, a longer time is required, because the light is then screened from the sitter on all but one side. Much, again, will depend on the colours of the objects to be depicted. If they be light, the impressions will be more quickly made, and if dark an additional time should be allowed. The effect when a Daguerreotype plate has had too much or too little light is easily perceived. Too much light will cause the white parts of objects to appear blue, the blacks become brown, and the finer demarkations of shading are destroyed. Such a picture is said to be "solarised" or "burnt." On the contrary, in a picture which has not had sufficient light, the lights and shadows are in strong contrast, and the darker portions of the object are not developed. With a still less degree of light, there is a general feebleness of impression, which no length of exposure to mercury vapour will strengthen.

The plate having been withdrawn from the camera, it is next transferred, in the dark, to the mercury-box, to bring out the latent picture. This is the most interesting part of the process, for now we have to ascertain whether all the trouble and care we have bestowed have been thrown away, or whether we have succeeded in obtaining a perfect picture most exquisitely finished. The impressions made on the iodine and bromine by the rays of light, though invisible, have yet such efficacy as to expose those portions of the silvered plate to the action of the vapour of

mercury, whilst the other parts are impervious to its action. The mercury vapours thus form the lighter parts of the picture, whilst the dark polish of the silver plate constitutes the shadows. The particles of mercury deposited on the plate are so minute as to be scarcely visible by a powerful microscope, and the evaporation of the liquid metal at the ordinary temperature of the atmosphere is sufficient to bring out the Daguerreotype picture when placed over it—but this would require three or four hours. To facilitate the operation a spirit-lamp is used, which should be carefully applied, that the mercury may not be too much heated. The mercury-boxes usually sold have thermometers attached to them, and the temperature should not exceed 150° Fah.; but a little experience will teach how to regulate the heat without a thermometer, by applying the fingers occasionally at the bottom, which should not become too hot to be touched. In a minute or two the picture will begin to develop itself, and will then gradually come out till it attains its greatest distinctness. If it remain too long, the details become less sharply defined; it is better, therefore, to remove the plate when all the objects appear distinctly developed. It is generally recommended to heat the mercury to the highest point allowed, then to withdraw the lamp till the mercury cools, and apply heat again, and so on until the deposition of mercurial vapour is completed; but we prefer lowering the flame of the spirit-lamp, so as to produce a mere glimmer, and to allow it to remain burning for three or four minutes, after which to leave the plate undisturbed till it cools. If, when this process is completed, there appears a perfect picture when the operator peeps into the box with a taper's light, the pleasure he experiences amply repays all the trouble he has taken, and he will feel disposed to exult as much at the product as if it were the result of his elaborated skill, whereas his only achievement has been that of having fixed the pencillings of Nature.

The picture is now obtained, but it is not yet secured. Were it to be exposed to light, the sensitive coating still upon the plate would pass through a variety of changes of colour, and darken into a purple. To prevent the further action of light, the plate must be immersed in a solution of hyposulphite of soda, in the proportion of not less than half an ounce to a pint of distilled water. This solution should be poured into a shallow vessel—a soup plate will answer very well—and the Daguerreotype should be immersed with its face upwards. Lift the plate gently up and down on each side, and in a few seconds the iodine will be removed. Then take the Daguerreotype carefully out, and immerse it in another vessel containing distilled water, if warm the better, and again in another bath of distilled water, to remove all traces of the soda. If these washings be done carefully the picture will be uninjured, but it will require great care in the subsequent process of drying to avoid impairing its effect. The plate must be held in a slanting direction for the water to drain off; care being taken to see that no particles of dust have settled on it, for if there have it must be again immersed in water. The spirit-lamp should be applied at the upper edge of the plate, and by blowing on it the drying will be promoted. Should the water collect on parts of the plate as if it were greasy, instead of spreading over the surface evenly, it must be blown away if possible before it dries, otherwise a mark will be left on the plate that may spoil the picture. Numerous annoying occurrences of this kind will happen, and it may be observed that the more strongly the picture is brought out, the more liable it is to be injured in the washing. It has occurred to us that one of the most beautiful pictures we have succeeded in obtaining, which was very distinct in details, forcible, and a pleasing likeness, was completely spoiled by stains in the subsequent process. The soda solution and water should not be twice used, lest any iodine remaining in the vessel should cause a stain.

After washing, the picture is permanent, and in this state all the first Daguerreotypes were finished. The thin film of mercury, however, is yet easily removed by a touch, nor has the picture attained the brilliancy and tone which it receives from the subsequent process of fixing by gilding, which was invented by M. Fizeau, to whom the Daguerreotype art is much indebted. For gilding the plate, a diluted solution of chloride of gold and of hyposulphite of soda is employed; in the proportions of 15 grains of the chloride to a pint of distilled water, and 45 grains of the hyposulphite in the same quantity of water. These should be dissolved in separate vessels, and then the gold solution poured very gradually into the other, stirring with a glass rod all the time. If this mixture of the two solutions be not carefully made, or if the soda solution be poured into the gold, the resulting mixture will be black, owing to the deposition of sulphate of gold. The quantity indicated will serve to gild a great number of plates, and may be kept for use as wanted. The plate to be gilded

must be placed horizontally, with its face upwards, on the lamp-stand. The surface is to be then floated over with spirits of wine, which may be poured on it and quickly drained off,—the only use of the spirits being to facilitate the flow of the gold solution. As much of the diluted chloride of gold is poured on as the plate will retain on its horizontal surface, and then the spirit-lamp is to be applied beneath to heat all parts equally. Presently the liquid will emit vapour, the picture will improve in brilliancy, and soon afterwards small bubbles will appear, at which point the process must be stopped. The gold is then poured off, and the plate washed with warm distilled water, and dried with the aid of the spirit-lamp, in the same manner as after the first washing.

The operation is now completed, and if every part of the process have been conducted with care and judgment, the artist is in possession of a picture which, in accuracy of outline and in the exquisite beauty with which it is finished, far surpasses any work of mere art. He may gaze long on its wondrous details with delight, which will be not a little enhanced by the pleasing self-deception that it has been done by himself! All his trouble seems recompensed—all his failures but increase the pleasure of this one complete success—and the difficulties he has had to encounter in gaining the prize only add to its value. He sees henceforth all difficulties removed, and in full confidence of his powers he even hopes to attain still greater perfection.

Let not the variety and required care of the manipulations discourage any who have a taste for the art from commencing the work, since perseverance is almost sure to be crowned with success. For two whole days were we in our first efforts without obtaining the trace of an image; and when at length a perfect picture burst into view in the mercury-box, the delightful feelings of the days of childhood seemed to be restored. By attending to the directions which our experience and recollection of difficulties surmounted suggest, the way will be in a great measure cleared, and it will be a source of gratification to think we have removed any obstacles that obstruct the attainment of success.

THE HOUSE OF PEERS.

SIR—My ideas and notions may be so very peculiar that there is no danger whatever of their contaminating public taste; which being the case, you will, perhaps, allow me to express my own opinion of the House of Peers. In a word, then, I take it to be if not exactly a failure, very far below what was to be expected—at least desiderated. As to conception, it is positively null: the character is that of a chapel, not of a senate-house; such is certainly the general idea, without any attempt at further or different idea. No original and poetic grasp of mind has been exhibited by the architect, who has merely appropriated to the occasion what he found ready made. The impressive solemnity which befits a hall in which are held the councils of a widely extended empire, does not there express itself. On the contrary, if there be too much of the chapel in some respects, there is too much of the ball or banqueting room in others. There is by far too much of glare and garishness, and not a little of *mesquinerie* also. Yes, I venture to say it, of *mesquinerie*, which reproachful epithet may, I think, be very justly applied to the throne. Instead of forming a principal feature of the general composition, that seat—not perhaps exactly an "easy chair"—is no more than a piece of furniture which might be put into any room,—a mere gilded chair, instead of being made to form an important, and leading feature in the ensemble. Judging from the one already executed, the frescos will be altogether insignificant—mere spots in the general decoration, and by no means brilliant ones; rather very flat and insipid specimens of pictorial art, and will show all the more so in consequence of the injurious contrast with the painted windows, which latter, in turn, owing to the same contrast, must appear harsh and glaring in colour.

Such at least is my feeling; and I must be allowed to say that I am greatly disappointed in the new House of Peers. No doubt it is calculated well enough to strike and also satisfy those who merely go into it, and just look about them; and who therefore giving themselves up to the mere first impression, are captivated by the sumptuousness of the place. Yet the test of architectural excellence is not the mere first impression alone, before the judgment has time to rally and collect itself, but the increased satisfaction produced on every fresh visit. If I did not exactly expect, I desiderated and still desiderate more convincing evidence of artistic power and artistic grasp of mind than I there discover; for while on the one hand the "house" is decidedly too ecclesiastical in character, it is on the other more characteristic of a ball-room or a banqueting room than of a senate-house where the most momentous interests are to be discussed. I may be wrong; and if so, either you or some one among your correspondents will take the trouble to set me right! In the meanwhile I remain,

ZERO.

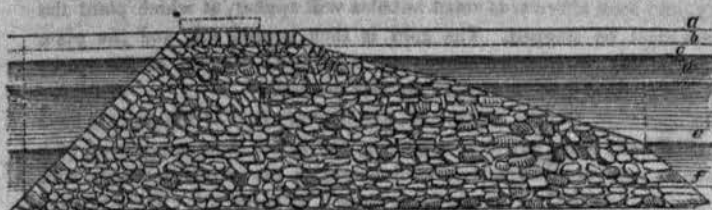
[We have given insertion to the above communication, not because we agree with the observations, but to give an opportunity to our readers for fair criticism.]—Ed.

CONSTRUCTION OF SEA WALLS.

(Continued from page 254.)

BREAKWATER IN DELAWARE BAY.

ANNEX (L).—Report of Commission of the United States' Engineers and Naval Officers, on the Form which should be given to Breakwaters, and Report on the Construction of the Breakwater in Delaware Bay.



Section of Breakwater in Delaware Bay, United States.

a, Top of breakwater, 30 feet wide.—b, Highest tide known.—c, Highest spring tide.—d, Lowest spring tide.—e, Level 15 feet below lowest spring tide.—f, Bottom 27 feet below lowest spring tide.—g, Average bottom 29.4 feet ditto.—The dotted lines on the top show a parapet to be made, if needful, 22 feet wide.

The following description of the Delaware Breakwater is compiled from the Report of a Board of Commissioners to the Secretary of the Navy, which was approved by the President of the United States in February 1829. The commission was composed of Commodore Rodgers, U.S. Navy; Brigadier-General Bernard, U.S. Engineers; and William Strickland, architect and engineer:—

With respect to these objects, upon which the solidity and durability of the work so essentially depend, it must be acknowledged that theory and mere speculation are utterly incompetent to fix, within precise limits, the degree of resistance to be given to a work exposed to so many and such incalculably violent efforts of the sea. But valuable inferences may be deduced from experimental results afforded by the construction of similar works in Europe, and described in an able paper presented to the French Institute by M. Cachin, general inspector of French Civil Engineers. Thus the stupendous works erected in Cherbourg in France, and at Plymouth in England, have been resorted to as guides in the investigation of the leading principles upon which the breakwater under consideration should be constructed.

If the road of Cherbourg is of the highest importance to France, that of Plymouth is probably of equal importance to Great Britain; as, among other advantages, it enables her to assemble at one point the fleets destined to watch the movements of her neighbours in the roads of Brest and Cherbourg; added to which, the connexion of the road of Plymouth with an extensive naval arsenal makes it a matter of much consequence that it should be rendered perfectly secure.

The works at Cherbourg fully answering the purposes for which they were erected, and demonstrating their importance, the Government of Great Britain caused the erection of a breakwater to be undertaken in the road of Plymouth, which was accordingly commenced in 1812.

At Plymouth the interior slope has an inclination of 57 feet altitude to 90 feet base, making an angle of 32° with the horizon. At Cherbourg this slope is of 45° inclination; and, since it has stood firmly under an altitude of more than 70 feet, it may be inferred that at Plymouth the interior slope might also have been kept at 45° .

The Board was, therefore, of opinion that, as the Delaware Breakwater must be 18 feet lower than that of Plymouth, and 30 feet lower than that of Cherbourg, there should be no hesitation in adopting the slope of 45° .

At Cherbourg, as at Plymouth, experience has taught that, if human power was able so to heap up materials as to fill up such a space in the deep, it required the agency of tempestuous waves so to dispose of them as to secure their permanent stability. On this score it would seem that the results obtained at Cherbourg from vicissitudes in 1812 were but partially known to the able projectors of the Plymouth Breakwater. Indeed, the base of 180 feet of that work, and its altitude of 57 feet, have received precisely the same ratio as that which the action of the sea had fixed between the base of 228 feet, and the altitude of 72 feet of the work at Cherbourg. The surface of the former work having been assumed to be a plane, while at Cherbourg the efforts of battering waves have produced a curved surface, it is hence to be apprehended that at Plymouth it may become necessary, in progress of time, to add new materials to the lower part of the slope.

The slope herein submitted has been framed out of the following facts and principles afforded by the Cherbourg Breakwater.

1. The part above the highest spring-tide having been for a short time battered by the waves, which had lost by their ascension a portion of their momentum, received from the action of the sea an inclination of nearly 2 feet base to 1 of altitude.

2. The part comprehended between the highest and lowest spring-tide is exposed, during the time of its rise and fall, to the greatest violence of the waves. Thus permanently swept by the sea, this portion of the slope has received an inclination of 11 feet base to 2 of altitude.

3. The part comprised between the lowest spring-tide and a horizontal plane 15 feet below it, is exposed to the shock of the waves only during the interval between the termination of the fall and the commencement of the rise of tide: it has, therefore, to withstand the efforts of the sea under a less inclination, viz., 3 feet base to 1 of altitude.

4. The lowest part of the slope comprehended between the latter plane and the bottom of the sea, remaining permanently submerged, and to a depth at which the agitation of the waves has attained its minimum, has assumed an inclination still less than the preceding, viz., 5 feet base to 4 of altitude.

These experimental results show that the effect of water against loose materials is to give to the mass in progress of time a slope, the inclination of which will increase in proportion to the force exerted against it.

It is on these data that the profile of the Delaware Breakwater has been delineated.

This fact, with others not dissimilar which have happened at Cherbourg, shows that the top of a breakwater must be elevated beyond the reach of submersion, and loaded with the largest and heaviest materials that can be procured, which should be laid in such a way that each shall present to the action of the sea the smallest possible superficies, and to the lateral materials the largest surface of friction.

These considerations induced the Board to recommend for the Delaware Breakwater a profile, or transversal section, of the following dimensions:—the inward slope at 45° , the top 30 feet in breadth, and at $5\frac{1}{4}$ feet above the highest spring tide; the outward slope of 39 feet altitude, and of $105\frac{1}{2}$ feet base; both dimensions measured in relation to a horizontal plane passing by a point taken at 27 feet below the lowest spring-tide. The base bears to the altitude nearly the same ratio as similar lines in the profiles of Plymouth and Cherbourg Breakwaters.

The experience acquired at Cherbourg has taught—

1. That stones of small size are not sufficient to withstand even a moderate action of the waves; for, being constantly tossed about, they acquire by attrition a round and smooth surface, which prevents their assuming any settled place in the mass.

2. That stones measuring 18 or 24 cubic feet, and weighing $1\frac{1}{2}$ to 2 tons, present a suitable resistance to the efforts of a moderate sea.

3. That larger blocks are required to withstand a violent sea; and that in the more exposed parts of the work their sizes should be still larger.

4. That if small materials were to be used, it would be indispensable to protect them externally by others of larger size.

5. That the smaller the external surface of a large block, the greater will be its stability.

6. That the largest blocks should be placed towards the top, in order to compensate, by their greater steadiness, the loss of weight and of stability caused by immersion to the materials located immediately under the water line.

The foregoing description of the Delaware Breakwater includes, with occasional alterations, the Report of the Board of Commissioners. The work has been executed so far in accordance with the views and plans therein detailed. The dimensions recommended in the Report have been adopted in its erection, with the exception of that portion designed for a breakwater, which is 1,000 yards in length; the length recommended was 1,200.

The work may be considered now so far finished as to have accomplished materially the purposes for which it was projected. Indeed, the plan of commencing the work at the adjacent extremities of its two portions has tended to yield a shelter to vessels during the whole progress of its construction.

CHERBOURG HARBOUR.

ANNEX (M).—Extracts from the Memoire of Mons. J. M. CACHIN, on the Breakwater of Cherbourg.

At the close of the 16th century, the French Government had resolved to provide, by means of art, those advantages for France which nature has conferred with such prodigality upon England, in the many ports she possesses in the English Channel.

It was more particularly, however, after the battle of La Hogue, that this necessity was more strongly felt, and the Government determined to create at Cherbourg a grand naval establishment, which in providing a safe and convenient harbour for their fleet, should give to the French nation the degree of power befitting its maritime position.

The American war had reanimated in the French mind the ambition of disputing with England the empire of the seas; and at the general peace, immediate steps were taken for fortifying the roadstead of Cherbourg.

The Bay of Cherbourg was selected as being opposite to the many almost natural harbours which Great Britain possesses in the Channel; as being in a very advanced position upon the ordinary track of ships, and offering every desirable facility for watching the movements of the enemy, interrupting his convoys, and for concentrating all the details of a grand maritime expedition.

The War Departments, which had been charged with proposing the divers projects for this grand enterprise, neglected to sound the roadstead, and to observe its maritime properties; and judging its extent as a harbour by its apparent surface, proposed the adoption of a plan which had been submitted to the French Government in 1778, by the director of fortifications at Cherbourg, for closing the roadstead by means of caissons filled with masonry, forming a jetty or "digue" from Point Homet to Pelée Island.

This project was most insufficient: it left exposed and without defence the most essential portion of the bay, that part best suited for the anchorage of large ships; and the very circumscribed area which it was proposed to protect against the violence of the sea and the attacks of an enemy, would have been accessible only to trading vessels, privateers, and other small craft.

In the year 1777, M. de la Bretonniere, capitaine de vaisseau, who was thoroughly acquainted with the localities, had proposed to cover the roadstead by a breakwater of sunken rocks. He republished in 1796 a memoir containing much valuable information in regard to the soundings, and other matters of great interest in regard to the general advantages of Cherbourg as a port of refuge for all classes of ships under all circumstances of wind and weather.

The project of constructing the breakwater in the direction of Point Homet, was abandoned at the remonstrance of M. de la Bretonniere, and, in 1780, it was resolved to adopt the direction which has since been given to it, viz., from the point Querqueville to Pelée Island.

After a long delay as to the means to be adopted for enclosing the anchorage by advanced works, M. de Cessart recommended the ingenious system of wooden caissons, in the form of truncated cones, 149 feet diameter at the base; 65 feet diameter at the summit, and 65 feet of vertical height.

It was proposed to sink 90 of these cones in all, leaving a passage at the east end of 2769 feet, and one at the west of 7674 feet.

It was, in the first instance, intended to fill them entirely with loose stones, but it was subsequently determined to fill them up with regular masonry, above the level of the equinoctial low tides, and to connect the cones with strong iron chains, thus forming a sort of open net work, which should divide the action of the sea, and create smooth water in the roadstead.

The proposed construction, mode of launching, and immersion of these cones, appeared to promise every success. One was built at Havre, and floated in 1783. It was then taken to pieces, transported to Cherbourg, and after some delay, caused by a gale of wind, was floated and sunk, on the 6th of June 1784, at a distance of 3835 feet from Pelée Island.

A second was sunk tangent to the base of the first, in a westerly direction, on the 7th July following, but a gale coming on on the 18th of August, before this second cone was filled with stones, it was carried away down to low water mark. This event was the cause of, or the pretext for, great changes in the dispositions which had in the first place been adopted.

It was found that the stones, dispersed by the breaking of the second cone, would entail the necessity of sinking a third at such a distance from the first, that the interval would not be protected from the violence of the sea. It was likewise considered, that, as the cones could be sunk only during the spring tides, the completion of the work would require 18 or 20 years' consecutive labour, and would cost 80,000,000 of francs. These considerations led the Government to direct that the cones should in future be only employed at intervals of 58 metres, 60 centimetres, and the intermediate space filled in with large blocks of stone, and thus to form a breakwater, which was to be carried up to low water level. These intervals were subsequently increased to 1280 feet; but after sinking 18 of these cones at different intervals, thus isolated and imperfectly filled, they soon experienced repeated damage, and this system of construction was accordingly soon abandoned. All the cones which the sea had spared being deemed useless, they were cut down to low water in the year 1789; one alone was left entire, to indicate the limits of the passage, but in spite of some care bestowed on its preservation, it fell to pieces on the 12th of February 1799. The successive destruction of all these cones, led to the recognition of the system of breakwaters of sunken rock as the only process calculated to ensure success.

From this period the sinking of stones was carried on with such activity, that by the end of the year 1790, the quantity of material sunk was computed at 2,665,400 metres cube. Hitherto but vague notions had been entertained of the depth of water, nature of the bottom, and of the force and direction of the currents at different stages of the tide. These essential considerations were neglected, and the establishment of the digue was resolved upon, at a distance of about 3,898 metres from the entrance of the merchant vessels' harbour, in an easterly and westerly direction, forming towards the centre a salient angle to the north of 169 degrees, which divides the "digue" into two branches, of which the westerly one is 2,232 metres, that on the east 1,536 metres in length, measured from the centres of the two cones which had been sunk at the extremities.

The angular disposition of the work thus determined, without regard to the principles which prescribed a configuration quite the reverse, in order to render it susceptible of the greatest resistance, was dictated by the necessity of not obstructing the fire of Forts Royal and Querqueville, destined to defend the entrance to the roadstead.

At this early stage, it would have been possible to modify the dispositions in regard to these forts, of which the one was only planned, and the other barely commenced; but the War Department insisted on carrying out its own plan of defence, and the Marine Department saw itself compelled to renounce the advantages which would manifestly have accrued from placing the breakwater more to the north, thus increasing the area of the anchorage without any serious increase of expense, or augmentation of the difficulties of construction.

This first error was followed up by a second no less grave, and which leaves no doubt that the soundings of the bay were then but very imperfectly known. The cone which was to form the eastern end of the digue was sunk in 25 feet (8 metres 12 centimetres) water at low tide, hence the water gradually shoals in the direction of Pelée Island, which is distant about 975 metres. This passage was thus narrowed with the view of obliging large ships to pass within good range of the fort on the island; but this purely military consideration led to the neglect of a most essential maritime condition, for the depth of water in this passage is insufficient for ships of the line at low water. It was likewise proposed, with the same defensive view, to narrow the western entrance; but after a careful examination of the depth of water, it was found necessary to establish the western extremity of the digue at a distance of 2,339 metres from fort Querqueville. But the passage of ships of the line thus established beyond good range of the above fort, sensibly affected the utility of this fortress; and had the naval and military projects been well concerted, it is not to be concealed, that the defences would have been susceptible of a more advantageous disposition, and that the greater part of the expense of the fort in question might have been saved. But all these inconveniences were discovered too late.

It was only in the month of July 1789 that orders were first given for taking correct soundings of the bay, and for ascertaining with accuracy the places accessible to vessels of all classes.

In 1792 the Legislative Assembly, convinced of the extreme importance of this great undertaking, procured a statement of the progress already made at an expense of 31,000,000 of francs, including cost of establishment and administration. Having fully recognised that the faults hitherto observed in the execution of the works proceeded from want of concert and combination in the different projects hitherto adopted, the Assembly ordered the Executive Government to name Commissioners, chosen by the departments of War, Marine, and the Interior, to report upon the merits of the works already executed, and to propose the best means of perfecting what had already been commenced, and of completing this great undertaking.

This Commission, amongst other important suggestions, gave it as their opinion that the stability of the upper part of the digue could not be reckoned upon without the employment of larger stones than those hitherto used, and which had become much diminished in size by their frequent displacement and friction; that large blocks, 51 to 69 centimetres cube had a presumed stability sufficient to resist the action of the sea, and that this stability would increase with the volume of the blocks of stone employed.

The general dispositions recommended by the Commission of 1792 were adopted by the Government, upon the strength of the advice of a committee, composed of several general officers and admirals, and engineers of the greatest eminence in the three departments of War, Marine, and the Interior.

It now only remained to determine the height to which it was necessary to elevate the breakwater, in order, not only to procure smooth water in the roadstead, but at the same time to afford every possible protection to fleets and convoys against the attacks of the enemy.

It was the unanimous opinion of all the practical persons who had observed the effect of the sea upon the digue since its commencement, that at low water, in bad weather, from seaward, the roadstead was perfectly calm; but that, as the tide rose, it became troubled; and that, two hours before and after high water, when the wave appeared to acquire a greater force in breaking upon the breakwater, the vessels, particularly those near it, were much troubled by the sea.

After having noted the height above low-water mark to which the sea reached two hours before and after high water, it appeared a constant rule, that when the waves became troublesome to the ships in the roadstead, the sea had risen 4 metres 70 centimetres.

Hence it was naturally concluded that it would be advisable to carry the summit of the breakwater at least 4 metres 70 centimetres (14 ft. 6 in.) below the level of the highest tides; that is to say, to 2 metres 44 centimetres (7 ft. 6 in.) above the level of the lowest tides, the rise in the sea outside being calculated at 22 feet, or 7 metres 15 centimetres.

But viewing the great advantages which would result from its being carried up to the level of the highest waves, it was not hesitated to propose its elevation to 9 feet (2 metres 92 centimetres) above the level of the highest sea outside; that is to say, to 31 feet (10 metres 7 centimetres) above the lowest tides.

But the revolutionary troubles put a stop to all further proceedings connected with the recommendations of the Commission of 1792; and the completion of this vast enterprise appeared to be indefinitely delayed, when, in November 1800, a new government turned its attention to this important object of public utility, and named a Commission, upon whose report in 1802, the government directed that the centre of the breakwater should be elevated 2 metres 92 centimetres above the level of the highest tides, with a breadth of 195 metres, whereupon to construct a battery of 20 pieces of artillery of the largest calibre; and that the extremities of the breakwater should be, ultimately, similarly constructed for a like purpose.

This was recommended in consequence of the great distance (7,017 metres) between Forts Royal and Querqueville, which was deemed too great to prevent enemies' ships from anchoring to the north of the breakwater, thence firing on vessels within the roadstead, themselves being beyond good range of the forts.

At this period (1802) these works previously undertaken, which had

been carried up to the level of low tides, had entirely disappeared. The sea had carried away from 15 to 18 feet of the summit, giving to the breakwater the following configuration :

	Base.	Height.
The interior slope, or that to the south..	12 50	12 50
Superior slope, north	47 50	6 20
Inferior slope, north.. ..	9	6 30

Upon this base, thus formed by the action of the sea, it was determined to attempt the erection of an artificial island, exposed to the most violent agitation of the waves. By the end of the year 1803, the central portion of the work was completed to low-water mark of ordinary tides. The modification and changes which the original breakwater had undergone, left no room to doubt that the small stones of which the then elevation was composed, would not resist the winter gales; that it would be necessary to consolidate the whole by a superstructure on the south side, composed of immense blocks of stone, to be raised to the height of the highest tides, as the only means of preventing the smaller materials from being washed away into the interior of the work by the north-east and north-west gales of winter. As anticipated, this superstructure resisted the force of the sea, prevented the washing away of the smaller materials, which, arrested by this barrier, gradually augmented the height of the breakwater, forming a solid and compact surface at a new slope, of which the base was about quadruple the vertical height.

It was, however, soon observed, that these small stones pressed up, and, transported by the northerly winds to a level above that of the sea, equally yielded to the same action in north-east and north-west gales. Under these circumstances of weather, of frequent recurrence in the winter of 1803, a portion of the stones which had been thrown in on the sea side became subject to a lateral displacement, and were deposited in great abundance in a conical mound at each extremity of the recently elevated central portion of the digue.

It was remarked, that the winds and the currents had both tended to give these mounds the precise configuration of the tracing of the proposed batteries; and thence it was naturally concluded, that the form proposed was that best adapted to insure stability, since it agreed so perfectly with that which the sea itself had assigned to the mass of stones set in motion in bad weather.

From motives of economy, the interior of the fort was composed of small materials; but the whole was necessarily revetted with large blocks, capable of offering an adequate resistance to the action of the sea. This was performed in a very simple and easy manner: in bad weather the blocks were cast overboard from the stone vessels, above the places which were dry at low water. In fine weather this was discontinued, and the stone vessels were moored over the required spot, or were sunk, so as to rest upon a berm or slip which had been left in the slope at the foot of the revetments. From the vessels thus sunk or moored, the blocks of stone were hoisted by their own tackle clear of their decks, when they were transported by cranes, or derricks, disposed on the summit of the breakwater, and deposited in their proper places on the revetments. By these simple and expeditious means, the central portion of the breakwater having been raised to the height of 2 metres 92 centimetres above the level of high-water, spring-tides, upon an extent of 195 metres in length, and 19 metres 50 centimetres in breadth, a battery was established thereon, armed, provisionally, with four 36-pounders and two heavy mortars.

In the subsequent construction of the terreplein and part of the parapet of the battery, owing to the bad weather and too great haste in constructing it, the precautions necessary to its thorough solidity were neglected, and a violent gale coming on ere the exterior revetment was completed, a portion of the temporary parapet, which had been formed with small materials not cemented, was destroyed. The mass of the battery suffered no injury; and the centre and the extremities of the terreplein resisted the action of the sea without the least alteration, and, notwithstanding the insufficient height and imperfect state of the exterior revetments, a garrison of 60 men remained in the battery in perfect safety.

In May 1805, the works were sufficiently advanced to arm the battery with 20 pieces of heavy ordnance within 24 hours.

The works suffered little material injury until the 12th February 1808, when, during a dreadful gale from the north-west, the sea submerged the battery, destroyed and upset the epaulements, and the wooden barracks of the garrison.

The main effect of this violent gale was to put an end to any further displacement of the materials; and the work has ever since presented the appearance of a natural slope of rocks, over which the ordinary "varechs" cross, and are developed in an unbroken undisturbed mode which proves the perfect stability of the work.

The examination made at this time of the new configuration which had been given to the mass of stones, confirmed and verified by subsequent experience, has established the fact, that jetties thus constructed, and exposed to the action of the sea, assume, between their summit and their base, four slopes essentially different, and which vary according to the violence of the waves, the duration of their action at the several parts in the rise and fall of the tides.

The situation of the exterior revetments of the battery being the effect of the natural action of the sea in its greatest agitation, was considered as that most suited to insure the permanency of the materials of which the work was composed; and accordingly, after the storm of 1808, new barracks were constructed for 60 men; a new parapet was raised to cover

the artillery of the port, but without making any modification in the exterior slopes, which have ever since maintained the exact degree which the sea had assigned to them, though these slopes have, since that period, never had the least care bestowed on them.

The digue, thus completed in its central portion, remained armed with 20 pieces of artillery during the whole war. In the year 1811 it was decreed to substitute for this temporary fort a permanent defence, thus described in the decree dated 7th July of that year:

The battery to be established upon the breakwater of Cherbourg will be constructed in an elliptical tour of masonry, of dressed blocks of granite, of which the great axis shall be 35 toises, and the smaller 19 toises, in conformity with the plans and sections annexed to the present decree, and to the following specifications.

The foundations will be established on the rock-work at low-water level.

Upon this massive foundation, which will be 28 feet high, and at the level of the terreplein of the existing battery, will be placed a barrack, of which the walls will be pierced with 78 loopholes, capable of containing a garrison of 60 men, water-cisterns, and powder-magazine.

The gorge of the battery will be defended by two flanks.

A general platform upon the roof of the barracks, which will be bomb-proof, will serve for the site of a casemated battery for nineteen 36-pounders. The embrasures will be 30 feet above high-water mark.

A second platform will be constructed above the casemates, to serve, in case of necessity, for another tier of guns.

That portion of the existing battery without the site of the tower will be preserved, and the slopes towards the sea, which protect it, will be carefully kept in repair.

BREAKWATERS OF CHERBOURG AND PLYMOUTH.

ANNEX (N).—*Report made to the Academy of Sciences. Paris, by M. GIRARD, in the name of the Commission composed of Messrs. PRONY, GIRARD, and DUPIN, upon a Mémoire by the Baron CACHIN, Inspector-general of Bridges and Roads, entitled, "Mémoire upon the Digue of Cherbourg, compared with the Jetty or Breakwater at Plymouth."*

The perpetual secretary of the Academy of the Mathematical Sciences certifies, that the following are extracts from the proceedings reported in the sitting of Monday, May 3, 1815.

The Commission appointed in 1792 assured itself by an attentive observation of the effects of the sea upon the digue, that the materials of which it was constructed had no stability until they were faced with large blocks of from 15 to 20 feet cube at least; but the most important modification which this Commission proposed in the construction of the work was, to carry the summit to the height of three metres above the highest spring tides, as the only means of guaranteeing the solidity of the work itself, which was the main object it was intended to effect.

The old digue or jetty, which had been provisionally carried up to the level of low water mark in the year 1784, had now offered an experience of 20 years. It was ascertained that the storms during this interval of time had lowered the summit from four to five metres; the interior slope had preserved the inclination which had been originally given to it of 45 degrees, but its exterior slope, which had been originally formed upon a uniform inclination of three metres of base to one of height, was found to be entirely changed, and presented two distinct slopes; that of the lower portion was of 9 metres of base to 6 metres 30 centimetres of vertical elevation, whilst the inclination of the superior or upper slope had become five times less; that is to say, of 47 metres 50 centimetres base to 6 metres 20 centimetres vertical height.

These observations demonstrated what was the profile of the greatest stability, which was the most important point to know; and as it was remarked that the principal effect of the action of the sea, in strong winds from seaward, was to carry from the outside to the inside of the breakwater the materials of which it was composed, it became necessary, after having opposed a sufficient obstacle to this displacement, to abandon to the action of the sea itself the task of arranging the exterior surface which was exposed to its force in the manner and in the slope most suited to their object.

Accordingly, towards the end of the year 1803, M. Cachin caused to be raised on the top of that portion of the digue which had been already elevated, a sort of parapet, built with very large blocks, of which the summit was carried up to the level of the highest tides; thus the smaller stones which had been cast into the sea, by chance as it were, on the exterior of the digue, at the depth of low water, were borne up by the force of the waves to the foot of this parapet, and were there disposed on a regular slope, which, offering the least resistance to the movement of the waves, possessed the greatest stability. During the production of this effect, the horizontal base of the exterior slope became about quadruple that of its height.

Besides the movement of the materials in a vertical direction, whenever the wind blows hard from the north, or perpendicularly to the digue, these materials receive an impulsion from the effect of the winds which blow from the north-east and north-west, and in consequence of this impulsion two accumulations have been formed at the extremities of that central portion of the digue destined to support the battery, in the shape of two conical mounds, which serve for épaulements for the work.

This peculiar configuration, the effect of natural causes, is also found to

coincide with that which the author of the *Mémoire* had indicated for the two end batteries.

It is here seen how, in leaving exposed to the action of the waves such materials as they can put in movement, these dispose themselves in the manner best adapted to their stability and preservation in a vertical position; but as nothing opposes itself to the movement which would be given to these materials in the direction of the length of the digue, the definitive effect of which movement would be the obstruction of the passes, it is indispensable, in order to prevent this effect, to face the whole exterior of the work with blocks of stone, sufficiently large to resist these oblique impulsions.

After having indicated the proceedings in detail, as well as the several modifications which it was judged expedient to adopt in the execution and dimensions in the central portion of the digue, M. Cachin gives an account of the effects which were produced on this, as it were, isolated mound by the gales of the 18th February 1807, of the 29th May of the same year, but, above all which, of that of the 12th February 1808, from the north-west.

A combination of extraordinary circumstances produced such a heavy sea that it submerged the floor of the battery, upset the parapet, and destroyed the wooden buildings which had been constructed on the terreplein of the work for the accommodation of the garrison.

The last-mentioned storm, the most violent on record, stowed the large blocks of stone with which the digue had been faced in fresh slopes, and with such regularity that they appeared to have been cemented by the hand of man; the successive examinations which have since been made have proved that, by the effect of this extraordinary overthrow, the materials have acquired a most perfect stability.

These examinations have also taught, that this equilibrium once established, the transverse section of the digue, on the sea side, assumes four essentially different slopes from the summit to the bottom of the sea.

Thus, the upper part, which is only reached by the tops of the waves, presents a slope of which the vertical height is to the base as 100 to 185.

The portion immediately below this, comprised between the high and low water (equinoctial) marks, is exposed to the most violent action of the sea during the whole flood and ebb; its slope is likewise the most inclined, the height being to the base as 100 to 540.

Below the low spring tides the surface is only exposed to the agitation of the waves during the first moments of the flood tide and the latter part of the ebb. The height of its slope to its base is as 100 to 302.

Lastly, the lowest part of the digue, which remains always submerged, not being exposed to the action of the waves, preserves a slope of which the height is to its base as 100 to 125.

After having pointed out the dimensions, and having described the means of construction of the Jetty at Plymouth, M. Cachin establishes a comparison between the real quantity and extent of the works respectively requisite to complete the Digue of Cherbourg and the Jetty or Breakwater of Plymouth; and also between the probable expense of each. The result of this is very simple, and easy to comprehend.

The length of Cherbourg Digue is 3,768 metres, and the area of its transverse section is 1,350 metres square. The expense of one metre of this profile, upon an experience of 16 years, is 8,717 francs. The length of Plymouth Breakwater is 1,364 metres; its profile, 993 square feet; and the expense of construction, 16,491 francs the metre.

After the experience of these two works, incomparably the greatest of their sort which the mind of man has ever contemplated to undertake, M. Cachin concludes with the observation, that, if man be strong enough to heap together rocks in the midst of the ocean, the action of the sea alone can dispose them in the manner most likely to ensure their proper stability.

Your Committee, partaking in this opinion, consider that this able engineer, in making known the result of his observations on the difficulties which he has encountered in the execution of his important labours, the means he has put in operation to surmount them, and, above all, his observations upon the configuration which bodies of water, violently agitated, tend to give to obstacles opposed to them, has rendered eminent service to those who may be hereafter called to the direction of similar operations.

We have the honour, in consequence, to propose the insertion of M. Cachin's *Mémoire* in the collection of the foreign men of science.

DECORATION OF THE PALACE AT WESTMINSTER.

REPORT of the Committee appointed to select subjects in Painting and Sculpture, with a view to the future Decoration of the Palace at Westminster.

Your Committee have first to observe that the general plan on which subjects were proposed to be selected has been defined by the Commissioners in their sixth report to her Majesty, in the following words:—"In accordance with the principles which have already guided us in deciding on the plan of Decoration in the House of Lords, viz., with reference to fresco-paintings, stained windows, and statues, proposed for that locality; and also in the selection of statues proposed for St. Stephen's Porch, St. Stephen's Hall, and the royal approaches: we conceive it to be the duty

of this Commission, for the better guidance of present and future artists, and in order to maintain a character of harmony and unity worthy of such a building, to determine a complete scheme for the future decoration of the Palace. We are of opinion, that in determining such a scheme, the especial destination of each portion of the building should be attended to; that in the selection of subjects, the chief object to be regarded should be the expression of some specific idea; and the second, its illustration, by means of some well-known historic or poetic incident adapted for representation in painting."

The duty which has devolved on your Committee being thus defined, their labours have been directed to the selection of subjects in accordance with the principle above explained. They have, for the present, given their attention to subjects for painting; a considerable number of names of distinguished persons to whom statues might with propriety be erected, having been before proposed, and of these, some have been selected by former Committees for particular localities.

ST. STEPHEN'S PORCH,

Containing two compartments, one measuring 26 feet high (to the point of the Gothic arch) by 16 ft. 8 in. wide; the other measuring 18 ft. 3 in. high, to the point of the arch, by 11 ft. 4 in. wide.

In this Porch will be four pedestals, on two of which it has been recommended to place the statues of Marlborough and Nelson; and your Committee were of opinion that the subjects of PEACE and WAR would be appropriate in the two compartments intended for painting.

ST. STEPHEN'S HALL,

Containing on the side walls, eight compartments, each measuring 14 ft. 5 in. wide, by 9 ft. 8 in. high; and two end compartments, one measuring 20 ft. 9 in. high, to the point of the arch, by 11 ft. 6 in. wide; the other measuring 17 ft. 6 in. high, to the point of the arch, by 11 ft. 3 in. wide.

An opinion has before been expressed, by the Commission generally, that as St. Stephen's Hall stands on the spot where the House of Commons was, during many centuries, in the habit of assembling, it should be adorned with statues of men who rose to eminence by the eloquence and abilities which they displayed in that House. Twelve personages selected on this principle, were accordingly named in the fourth report of the Commission to her Majesty.

Your Committee conceived that the walls might properly be decorated with paintings, illustrating some of the greatest epochs in our constitutional, social, and ecclesiastical history, from the time when the Anglo-Saxon nation embraced Christianity to the accession of the House of Stuart; and that the following subjects would be well adapted for this purpose:—

I. IN THE STATE—(For the Side Compartments).

A Sitting of the Wittenagemot.	An early Trial by Jury.
The Feudal System. The Homage of the Barons to William the Conqueror.	The Signing of Magna Charta.
The origin of the House of Commons. The first Writ brought down to the City of London.	The Abolition of Villeinage.* A Lord, on his death bed, attended by the Clergy, manumitting his Vileins.
The termination of the Baronial wars. Stanley and Oxford crowning Henry VII. over the dead body of Richard III.	The Privileges of the Commons asserted by Sir Thomas More against Cardinal Wolsey.

II. IN THE CHURCH—(For the End Compartments).

West End.	East End.
The Conversion of the Anglo-Saxons to Christianity. The Preaching of St. Augustine.	The Reformation. Queen Elizabeth receiving the Bible in Cheap-side.

THE CENTRAL HALL,

Containing four compartments, each measuring 17 ft. 7 in. high, to the point of the Gothic arch, by 12 ft. 7 in. wide; and three small panels underneath three of the large compartments, each measuring 5 ft. 5 in. high, to the point of the arch, by about 4 ft. 6 in. wide.

Your Committee, bearing in mind that this Hall is the central point of the whole building, were of opinion that the nationality of the component parts of the United Kingdom should be the idea here illustrated, and would be appropriately expressed by representations of the four patron saints, St. George, St. Andrew, St. Patrick, and St. David, in the four compartments intended for painting; and that in the three small spaces underneath three of the compartments the heraldic emblazonings of the Orders of the Garter, of the Thistle, and of St. Patrick, might be introduced.

CORRIDORS FROM THE CENTRAL HALL,

Consisting of the Peers' Corridor, the Commons' Corridor, and the Central or Public Corridor.

Your Committee were of opinion that the corridors which join the two Houses might properly be decorated with paintings illustrative of that great contest which commenced with the meeting of the Long Parliament

* "The holy fathers, monks, and friars, in their confession, and specially in their extreme and deadly sicknesses, burdened the consciences of them whom they had under their hands: so that temporal men, by little and little, by reason of that terror in their consciences, were glad to manumit all their villeins."—Sir Thomas Smith's 'Commonwealth,' book iii. c. 10.

and terminated in 1689. It will be seen that the subjects have been selected on the principle of parallelism, and that an attempt has been made to do justice to the heroic virtues which were displayed on both sides.

THE PEERS' CORRIDOR,

Containing eight compartments intended for painting, each measuring 9 ft. 6 in. wide by 7 feet high.

Charles I. erecting his Standard at Nottingham.

Basing House defended by the Cavaliers against the Parliamentary army.

The Expulsion of the Fellows of a College at Oxford for refusing to sign the Covenant.

The Burial of Charles I.

Speaker Lenthall asserting the Privileges of the Commons against Charles I., when the attempt was made to seize the five Members.

The setting out of the Train Bands from London to raise the Siege of Gloucester.

The Embarkation of a Puritan Family for New England.

The Parting of Lord and Lady Russell.

THE COMMONS' CORRIDOR,

Containing eight compartments intended for painting, each measuring 7 ft. 9 in. wide by 6 ft. 6 in. high.

Charles II. assisted in his Escape by Jane Lane.

The Executioner tying Wishart's book round the neck of Montrose.

Monk declaring for a Free Parliament.

The landing of Charles II.

Alice Lisle concealing the Fugitives after the Battle of Sedgemoor.

The Sleep of Argyll.*

The Acquittal of the Seven Bishops.

The Lords and Commons presenting the Crown to William and Mary in the Banqueting House.

THE CENTRAL CORRIDOR,

Containing six compartments, each measuring 8 ft. 9 in. high by 7 feet wide.

The paintings in St. Stephen's Hall, and in the corridors which join the two Houses, illustrate the gradual progress of our institutions during the interval which elapsed between the introduction of Christianity and the Revolution. It has been thought that the central corridor might with advantage be adorned with paintings exhibiting in strong contrast the extremes which are separated by that interval. With this view, six subjects have been selected: in three, Britain appears sunk in ignorance, heathen superstition, and slavery; in the other three, she appears instructing the savage, abolishing barbarous rites, and liberating the slave.

The Phœnicians in Cornwall.

A Druidical sacrifice.

Anglo Saxon Captives exposed for sale in the Market-place of Rome.

Cook in Otaheite.

English Authorities stopping the Sacrifice of a Suttie.

The Emancipation of Negro Slaves.

THE UPPER WAITING HALL.

The subjects for six (out of eight) compartments in this locality, have been before proposed to be selected from the following poets: Chaucer, Spenser, Shakespeare, Milton, Dryden, and Pope. The choice of such subjects being left to the artists appointed, or to be appointed, to execute them, after they shall have been approved by the Commissioners.

THE HOUSE OF PEERS.

The subjects for the six compartments intended for painting, and the selection of historical personages proposed for statues to be placed in the 18 niches, as well as the decorations for the stained windows, have been determined by former Committees.

THE PEERS' ROBING ROOM,

Containing three large compartments, two measuring 20 feet wide by 10 ft 6 in. high, the third measuring 22 feet wide by 10 ft. 6 in. high; and six smaller compartments, each measuring 7 feet wide by 10 ft. 6 in. high.

Your Committee being desirous to vary the proposed decorations, and conceiving that Scripture subjects, as affording scope for the highest style of design, and as being especially eligible on other grounds, should by no means be excluded, considered that the above-named locality, in which the principal compartments intended for painting, are of considerable magnitude, would be well adapted for such subjects. Your Committee were of opinion that the illustrations should have reference to the idea of Justice on earth, and its development in Law and Judgment, and that the following subjects would be appropriate.

In the single large compartment on the west side, 1. Moses bringing down the Tables of the Law to the Israelites.

In the two small compartments on the east side, 2. The Fall of Man, and 3. His Condemnation to Labour.

On the south side, in the larger compartment, 4. The Judgment of Solomon; and in the two smaller, 5. The Visit of the Queen of Sheba, and 6. The Building of the Temple.

On the north side, in the larger compartment, 7. The Judgment of Daniel; and in the two smaller, 8. Daniel in the Lion's Den, and 9. The Vision of Daniel.

* See Woodrow, 'Church History,' book III, c. 9, s. 9.

THE ROYAL ANTECHAMBER,

Containing in the upper part of two of the walls, six large compartments (three on each side), measuring 13 feet wide by 10 feet 9 inches high. Twenty-eight upright narrow compartments, measuring 5 feet 7 inches high, by about 2 feet 6 inches wide; and 12 panels for carved work, four measuring 6 feet 9 inches wide, by 2 feet 9 inches high; and eight measuring 2 feet 2 inches square.

Your Committee considered that the six large compartments in this locality, being at a considerable height, might be filled with copies in tapestry, of the defeat of the Spanish Armada, taken either in part, or altogether from the designs of the tapestry originally existing in the House of Lords, which your Committee conceived, it is of great importance to preserve, as far as possible, to the nation.

That the 28 upright compartments might be appropriately filled with portraits relating to the Tudor family:

1. Henry VII.—2. Elizabeth of York.—3. Arthur, Prince of Wales.—4. Katharine of Aragon.—5. Henry VIII.—6. Anne Boleyn.—7. Jane Seymour.—8. Katharine Howard.—9. Anne of Cleves.—10. Katharine Parr.—11. Edward VI.—12. Queen Mary.—13. Philip II.—14. Queen Elizabeth.—15. Lewis XII.—16. Princess Mary, Queen of France, Duchess of Suffolk.—17. Charles Brandon, Duke of Suffolk.—18. The Marchioness of Dorset.—19. Lady Jane Grey.—20. Lord Guildford Dudley.—21. Princess Margaret, Queen of Scotland, Countess of Angus.—22. James IV.—23. Douglas, Earl of Angus.—24. James V.—25. Mary of Guise.—26. Mary, Queen of Scots.—27. Francis II.—28. Lord Darnley.

That the twelve panels might be filled with the following subjects in carved work.

1, 2. The Field of the Cloth of Gold, and the visit of Charles V. to Henry VIII., in the two compartments on the east and west sides.

3, 4, 5. The Escape of Mary Queen of Scots, the Murder of Rizzio, and Mary looking back on France, in the three compartments on the south side, west of the door. The Escape of Mary Queen of Scots occupying the centre panel.

6, 7, 8. Queen Elizabeth knighting Drake, Raleigh spreading his Cloak as a Carpet for the Queen, and Raleigh landing in Virginia, in the three compartments on the south side, east of the door. The subject of the knight- ing of Drake occupying the centre panel.

9, 10, 11, 12. On the north side, Edward VI. granting a Charter to Christ's Hospital, Lady Jane Grey at her studies, Sebastian Cabot before Henry VII., Katharine of Aragon pleading.

THE ROYAL GALLERY.

A considerable space on each side wall, measuring 77 feet 6 inches wide, not being subdivided into compartments, your Committee were of opinion that such space should be occupied by one large, and two smaller subjects; the smaller corresponding in width with the width of one window, and measuring 12 feet 6 inches wide by 11 feet 6 inches high; the larger comprehending the width of three windows, and measuring 45 feet wide by 11 feet 6 inches high. Of the remaining compartments, defined by the architect, two on the side walls measure each 13 feet 3 inches wide by 11 feet 6 inches high; four on the same level, in the end wall, measure 12 feet 2 inches wide by 11 feet 6 inches high; the six remaining compartments, three at each end, in the upper part of the walls, measure 12 feet 2 inches wide by 19 feet 7 inches high. The compartments would therefore be eighteen in number.

Your Committee were of opinion that the subjects for the Royal Gallery should relate to the military history and glory of the country, and that the following subjects would be appropriate.

In the three upper compartments in the south wall:—

1. Boadicea inciting her army.
2. Alfred in the Camp of the Danes.
3. Brian Boroihme overcoming the Danes at the Bridge of Clontarf.

In the three upper compartments in the north wall:—

4. Edith finding the dead of Harold.
5. Richard Cœur de Lion coming in sight of the Holy City.
6. Eleanor saving the life of her husband, afterwards Edward I., by sucking the poison from a wound in his arm.

In the compartments next the proposed large compartment on the west wall:—

7. Bruce, during a retreat before the English, protecting a woman borne on a litter, and checking the pursuers.
8. Philippa interceding for the lives of the citizens of Calais.

In the lower compartments on the north wall:—

9. Edward the Black Prince entering London by the side of King John of France.
10. The Marriage of Henry V., at Troyes, with the Princess Katharine of France.

In the compartments next the proposed large compartment on the east wall:—

11. Elizabeth at Tilbury.
12. Blake at Tunis.

In the remaining compartment on the east wall:—

13. Marlborough at Blenheim.

In the lower compartments on the north wall:—

14. The Death of Wolfe.

15. The Death of Abercrombie.

In the remaining compartment on the west wall:—

16. Lord Cornwallis receiving the Sons of Tippoo as hostages.
In the large compartment on the west wall:—

17. Trafalgar; the Death of Nelson.

In the corresponding compartment on the east wall:—

18. Waterloo; the meeting of Wellington and Blucher.

THE QUEEN'S ROBIN ROOM,

Containing compartments of various dimensions, adapted for painting and other decorations.

Your Committee, influenced by the considerations before expressed as to the expediency of varying the character of the decorations proposed, were of opinion that a series of paintings, and other works of art, illustrating the legend of King Arthur, would be appropriate in this locality; and your Committee unanimously agreed to recommend to the Commission, that the execution and entire superintendence of such decorations should be entrusted to Mr. Dyce, who has already executed a fresco in the House of Lords.

THE GUARD ROOM,

Containing two compartments, each measuring 12 feet wide by 8 feet high.

Your Committee conceived that these compartments might be filled with the following subjects:—

1. Young Talbot defending his Father in Battle.

2. Isabella Douglas barring the Door with her Arm to protect James I. of Scotland.

THE LOBBY OF THE GUARD ROOM,

Containing one compartment, measuring 14 feet 5 inches high, to the point of the Gothic arch, by 10 feet wide. For this locality your Committee selected the subject of St. Edmund the Martyr slain by the Danes.

THE NORMAN PORCH,

Containing two compartments, each measuring 18 feet 2 inches high, to the point of the Gothic arch, by 10 feet 10 inches wide.

It was the opinion of your Committee that these compartments would be appropriately filled with the two following subjects:—

1. Canute reproving his Courtiers.

2. Queen Elizabeth on the sea-side after the defeat of the Spanish Armada.

Your Committee conceived that the subjects in all the localities mentioned should be accompanied with inscriptions, and, in some instances, with appropriate mottoes; that in the last named subject the motto might be "Afflavit Deus et dissipantur," and in the subject of Canute, "Nemo Dominus nisi Deus."

THE PEERS' AND COMMONS' REFRESHMENT ROOMS.

The compartments in the two Rooms belonging to the Peers might be appropriated to views of places of the chief importance within the United Kingdom. The compartments in the other Rooms to views of the most remarkable places in India and the Colonial possessions of the Crown. Space might also be found for subjects connected with rural scenery, the Harvest, the Chase, &c.

THE PAINTED CHAMBER, BEING THE HALL OF CONFERENCE BETWEEN THE TWO HOUSES,

Contains 13 compartments adapted for painting: two on the east side, measuring 10 feet 4 inches high by 7 feet 4 inches wide: five on the west side, the centre compartment measuring 10 feet 4 inches high by 16 feet 4 inches wide: two compartments next the corners measuring 10 feet 4 inches high by 9 feet wide, and two over the doors, measuring 4 feet 6 inches high by 6 feet 9 inches wide. Three on the north side, the centre compartment measuring 10 feet 4 inches high by 14 feet 3 inches wide, and two smaller compartments, each measuring 7 feet 10 inches high by 4 feet 8 inches wide: and three on the south side corresponding with those on the north side.

Your Committee conceived that the subjects for painting in this locality might have reference to the acquisition of the countries, colonies, and important places constituting the British Empire; and that the following subjects would be appropriate:—

In the centre compartment on the west side, 1. The Marriage of Strongbow and Eva, daughter of Dermot, King of Leinster.

In the centre compartment on the south side, 2. Edward I. presenting his infant Son to the Welsh as their Prince.

In the centre compartment on the north side, 3. James VI. of Scotland receiving the news of the Death of Queen Elizabeth; or Setting out for England as James I.

In the two compartments, next the corners, on the west side:—

4. Lord Clive in the Battle of Plassy.

5. Penn's Treaty with the American Indians.

In the two compartments on the east side:—

6. The Colonization of Australia.

7. The Treaty of Nankin.

In the two compartments over the doors on the west side:—

8, 9. Incidents illustrating the Voyages to the North and South Poles.

In the small compartments on the south side:—

10, 11. Incidents relating to the acquisition of Mauritius and the Cape of Good Hope.

In the two small compartments on the north side:—

12. Sir George Rooke planting the Standard of England on Gibraltar.

13. The Surrender of Malta.

The entrance from Old Palace Yard is also intended to contain some compartments for painting, but your Committee conceived that it would be proper to postpone the consideration of subjects for this locality as it is not yet certain whether paintings can be seen in it to sufficient advantage.

With regard to the technical method in which the paintings proposed should be executed, your Committee, although not prepared to offer a general recommendation on this subject, were of opinion that the pictures in the three corridors leading from the Central Hall, and the pictures in the Refreshment Rooms should be painted in oil; and that the Queen's Robing Room, St. Stephen's Hall, and the Royal Gallery should be painted in fresco. The representations of the four Patron Saints, from their size and situation, might be advantageously executed in Mosaic (like the four Evangelists in the pendentives of the Cupola of St. Peter's), thus giving an opportunity for the introduction into England of an art highly valued in other times and countries.

Your Committee have further to observe that moveable oil paintings, not coming within the general plan proposed, might be placed in Committee Rooms and in other parts of the building.

BRITISH ASSOCIATION.

(Continued from page 261.)

"On Anemometers and Resolving Scales." By Captain COCKBURN.

The advantage of a correct statement of the winds at sea has, for some years, been most apparent to me. Since the introduction into the naval service of a certain formula for stating the force of the wind, represented by numbers from 1 to 12, according to the sail carried and speed of a well-conditioned man-of-war, and this depending upon the opinion of the officer of the watch, the notations are as various as the opinions on such a subject must be; and I certainly have seen great discrepancies noted on the ship's log-book. This evident evil is the immediate cause of my attempting to make an anemometer which might correct it. The concave form of the revolving wings of this instrument was taken from a paper read on the subject last meeting. The concave surface holding one-third more wind than the convex, by theory it would revolve one-third as fast as the wind; consequently, three times the distance described by a cup in a revolution would be the velocity of the wind in the time occupied; this is supposing the form of the cup to be a perfect hemisphere, and no friction either in the mechanism of the instrument or in the air; but as there must be friction and resistance from both these causes, this necessarily involves a correction, which must be determined by experiment, in order to establish the value of the revolutions. From the experiments I have made on the top of railway carriages and in steam boats, the correction for the large-sized cups is $\frac{1}{5}$ or $\frac{1}{4}$. I do not by any means consider this to be decisive; the results have been various, from the unsteadiness of the wind during the trials, and from the mass of air carried along by the moving body: this will make the multiple 3.5 instead of 3. I am persuaded, also, that a different multiple will be required at moderate and at great velocities; but I have not been able to ascertain it. This value depends also upon the circumference of the circle described by the cups, their form, and weight. I shall not enter into the relative advantages of the forms and sizes of those I have had made: the diameters of each are, from centre to centre of the cups, including the arms, 12, 10, and 8 inches. Those simple multiplying wheels I have used may be substituted by the plan adopted for gas-meters, which I think preferable.

"On Changes in the Position of the Transit Instrument occasioned by the Temperature of the Earth, from the Observations of Prof. C. P. SMYTH, of Edinburgh." By Prof. POWELL.

Mr. Mallet, in an address to the Geological Society of Dublin, mentioned that Sir W. R. Hamilton had noticed certain changes of level in the transit instruments at his observatories; and that Dr. Robinson had also found such a change both in the general level of the observatory and also a motion in azimuth, recurring at annual periods, and apparently depending on the temperature of the earth;—but no details of such observations were given. Prof. C. P. Smyth has pursued such observations in detail at the observatory on the Calton Hill, Edinburgh, aided by the thermometric determinations of the changes of the temperature in the subjacent soil, made under the direction of Prof. Forbes, by thermometers sunk in the ground. The data he used were those obtained at depths of 5 feet, 3 feet, and in contact with the pier of the observatory. The movements, both in the level of the transit, and also in azimuth, are laid down graphically in curves, and exhibit a remarkable agreement with the changes in temperature, the western end of the level being highest in summer, and the deviation of the west end of the transit axis being greatest towards the south in winter.

"On the Coloured Glass employed in Glazing the new Palm House in the Royal Botanic Garden at Kew." By R. HUNT.

It has been found that plants growing in stove houses often suffer from the scorching influence of the solar rays, and great expense is frequently incurred in fixing blinds to cut off this destructive calorific influence. From the enormous size of the new Palm House at Kew, it would be almost impracticable to adopt any system of shades which should be

effective—this building being 363 feet in length, 100 feet wide, and 63 feet high. It was therefore thought desirable to ascertain if it would be possible to cut off these scorching rays by the use of a tinted glass, which should not be objectionable in its appearance, and the question was at the recommendation of Sir W. Hooker and Dr. Lindley submitted by the Commissioners of Woods, &c. to Mr. Hunt. The object was, to select a glass which should not permit those heat rays which are the most active in scorching the leaves of plants to permeate it. By a series of experiments made with the coloured juices of the palms themselves it was ascertained that the rays which destroyed their colour, belonged to a class situated at that end of the prismatic spectrum which exhibited the utmost calorific power, and just beyond the limits of the visible red ray. A great number of specimens of glass variously manufactured were submitted to examination, and it was at length ascertained that glass tinted green appeared likely to effect the object desired most readily. Some of the green glasses which were examined obstructed nearly all the heat rays—but this was not desired, and from their dark colour these were objectionable, as stopping the passage of a considerable quantity of light, which was essential to the healthful growth of the plants. Many specimens were manufactured purposely for the experiments by Messrs. Chance of Birmingham, according to given directions, and it is mainly due to the interest taken by these gentlemen that the desideratum has been arrived at. Every sample of glass was submitted to three distinct sets of experiments—1st. To ascertain, by measuring off the coloured rays of the spectrum, its transparency to luminous influence. 2nd. To ascertain the amount of obstruction offered to the passage of the chemical rays. 3rd. To measure the amount of heat radiation which permeated each specimen. The chemical changes were tried upon chloride of silver, and on papers stained with the green colouring matter of the leaves of the palms themselves. The calorific influence was ascertained by a method employed by Sir John Herschel in his experiments on solar radiation. Tissue paper stretched on a frame was smoked on one side by holding it over a smoky flame, and then while the spectrum was thrown upon it the other surface was washed with strong sulphuric ether. By the evaporation of the ether the points of calorific action were most easily obtained, as these dried off in well defined circles long before the other parts presented any appearance of dryness. By these means it was not difficult, with care, to ascertain exactly the conditions of the glass, as to its transparency to light, heat, and chemical agency (actinism). The glass thus chosen is of a very pale yellow-green colour, the colour being given by oxide of copper, and is so transparent that scarcely any light is intercepted. In examining the spectral rays through it, it is found that the yellow is slightly diminished in intensity, and that the extent of the red ray is affected in a small degree, the lower edge of the ordinary red ray being cut off by it. It does not appear to act in any way upon the chemical principle, as spectral impressions obtained upon chloride of silver are the same in extent and character as those produced by the action of the rays which have passed ordinary white glass. This glass has, however, a very remarkable action upon the non-luminous heat-rays, the least refrangible calorific rays. It prevents the permeation of all that class of heat-rays which exist below and in the point fixed by Sir William Herschel, Sir H. Englefield, and Sir J. Herschel, as the point of maximum calorific action. As it is to this class of rays that the scorching influence is due, there is every reason to conclude that the use of this glass will be effective in protecting the plants, and, at the same time, as it is unobjectionable in point of colour, and transparent to that principle which is necessary for the development of those parts of the plant which depend upon external chemical excitation, it is only partially so to the heat-rays, and it is opaque to those only which are the most injurious. The absence of the oxide of manganese, commonly employed in all sheet glass, is insisted on, it having been found that glass, into the composition of which manganese enters, will, after exposure for some time to intense sun-light, assume a pinky hue, and any tint of this character would completely destroy the peculiar properties for which this glass is chosen. Melloni, in his investigations on radiant heat, discovered that a peculiar green glass, manufactured in Italy, obstructed nearly all the calorific rays; we may, therefore, conclude that the glass chosen is of a similar character to that employed by the Italian philosopher. The tint of colour is not very different from that of the old crown glass; and many practical men state that they find their plants flourish much better under this kind of glass than under the white sheet glass, which is now so commonly employed.

"On the Potassium Battery." By Mr. GOODMAN.

An amalgam of mercury and potassium was placed in a vessel closed with a diaphragm at one end, and holding mineral naphtha. This was plunged into an acid solution, or a solution of sulphate of copper, containing a platina plate. By the action of the acid through the skin, the oxidation of the potassium was effected; and by connecting these plates with a voltameter, water was readily decomposed, or with a galvanometer a considerable deflexion produced.

"On a System of Colouring Geological Maps." By J. W. SALTER.

Hitherto geologists have represented the British strata by colours taken from the general hue of the rock, modified by the necessity of using bright tints and distinguishing adjacent formations by colours strongly contrasted. Continental geologists have not entirely adopted these colours, nor is there perfect accordance even in the maps of Englishmen. Mr. Salter proposed to remedy the inconvenience and uncertainty attending the present method

of colouring maps by introducing a system capable of universal adoption. The same colour, he says, should always be employed for the same group of rocks, various shades of that common colour being sufficient to distinguish, and at the same time combine, all the subdivisions of that group. Again, the colours used to designate systems of strata should follow in some constant order. The chromatic scale naturally suggested itself as the most harmonious gradation of colours, and accordingly Mr. Salter proposed to represent the Silurian strata by *Violet*; Carboniferous, *Blue*; Triassic, *Green*; Oolitic, *Yellow*; Cretaceous, *Orange*; Tertiary, *Red*. It was necessary to use a more intense red, with the addition of various markings, for the granitic rocks.

Mr. GREENOUGH referred to the pamphlet accompanying his geological Map of England, for an exposition of the principles by which he was guided,—which were approved of by the English geologists, and from which the French had departed with regret.—Mr. PHILLIPS and Sir H. DE LA BECHE recommended the adoption of one colour for each system, employing engraved lines of various kinds to distinguish the subdivisions, thereby diminishing the cost and increasing the accuracy of coloured maps.—Sir R. I. MURCHISON said he had once attempted to apply the scheme now advocated by Mr. Salter, but found it, practically, less serviceable than Mr. Greenough's, which was the basis of all the other maps.

HYDRAULIC MACHINE FOR RAISING WATER, &c.

Invented by MICHAEL SCOTT, Engineer of the Liverpool Water Works.

This machine was originally planned as a substitute for the common air pump in marine steam engines. As such I will first speak of it. Some years ago I was engaged in designing an engine which it was desirable to compress into the smallest possible bulk. The chief difficulty was the air pump and its attachments, which, if the ordinary arrangement was adopted, would occupy valuable space and make the engine complex. Observing this, I determined, if possible, to get rid of this pump altogether, and with this view, designed the machine as represented in fig. 1, where A is a pipe passing through the bow of

Fig. 1.

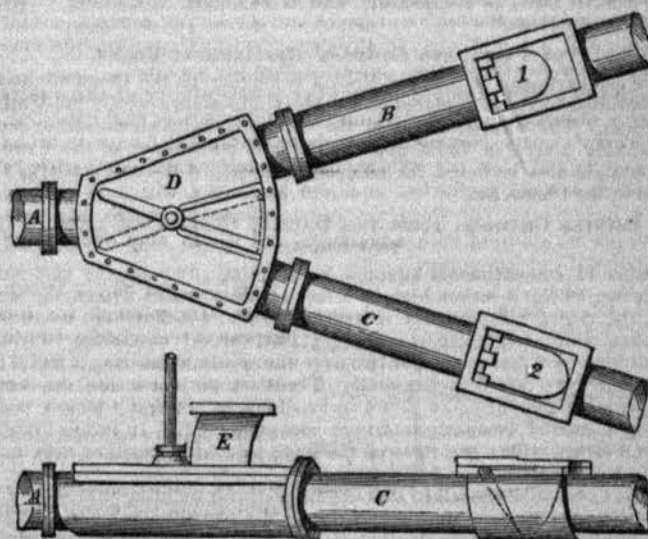


Fig. 2.

the vessel, which, at a convenient distance aft, diverges into two branches, which branch pipes again respectively debouch into the sea near the stern. D is a double hinge valve, moveable by a brass rod passing through a stuffing box on the top of the pipe. By this rod the valve D may be thrown to either side of the chamber so as to shut the communication between the pipe A and the pipe B or C, as the case may be, on the one side, and on the other side, so as to open the port between one of the pipes B or C and the pipe E, which descends from the condenser.

It will be observed, also, that there are two valves marked 1 and 2, one in each pipe opening upwards, which allow the water to pass out, but prevent its return. These valves may be equilibrated, and also opened or shut, by a crank joined to the axle which passes through the side of the pipe. So much for the configuration; now for the mode of action. Suppose the ship to be in motion (going ahead) and the valve D in the position shown, then the water will rush through the pipe A, and there being no obstruction offered, will pass through C and out at the stern. But let us throw the valve D to the other

side of the chamber, as shown by the dotted lines, the water entering at A now flows through pipe B, but the water in pipe C having been in motion its momentum will carry it onwards in the original direction, leaving a vacuum behind; at the same time it will be observed, that the port has been opened between pipe C and the condenser, and the water of condensation and vapour will rush out of the condenser into the pipe C. On again reversing the valve D, the same effect is produced in pipe B, and so on alternately.

Having thus briefly explained the form and operation of the machine, we have now to inquire what extent of vacuous space is likely to be obtained under ordinary circumstances.

Let P = the weight of the column of water in lbs.; G = the co-efficient of gravity = 32; V = the velocity in feet per second.

Then the vis viva of the water = $\frac{P}{G} V^2$.

Again, let A = the area of the pipe in square inches; R = the resistance due to the immersion at atmospheric pressure; L = the length of the vacuum in feet.

Then we have the mechanical effect overcome by the water while stopping = $A \times R \times L$. But this mechanical effect is equal to half the vis viva.

$$\text{Hence, } A \times R \times L = \frac{1}{2} \frac{P}{G} \times V^2, \text{ or } L = \frac{P \times V^2}{2 \times G \times A \times R}.$$

Let us now apply this formula to a particular case. Suppose the vessel to be 110 feet between the perpendiculars, and the length of the pipe to be 90 feet, diameter 6 inches; say she is propelled by one engine of 30-inch cylinder, and 3 feet stroke, then the air-pump would have a capacity of about 4,300 cubic inches.

Again, take the speed of the vessel at 14 miles per hour, or 20 feet per second, then we have—

$$\begin{aligned} P &= 1092 \text{ lb.} & A &= 28 \text{ square inches.} \\ G &= 32 & V &= 20 \text{ feet per second.} \\ R &= 17 \end{aligned}$$

$$\text{Hence } L = \frac{1092 \times 20^2}{2 \times 32 \times 28 \times 17} = 14 \text{ feet 4 inches.}$$

The contents of which is 4896 inches, and with a velocity of 20 feet per second, the machine will make one stroke per second, whilst the engine will not go above 45 strokes at most; therefore, the machine would be one-third more powerful than the pump.

Though the above example proves the practicability of the application as a substitute for the air-pump in such cases as contemplated, viz., light river boats moving at a high velocity, still I wish it to be clearly understood that in ordinary cases, such as we meet with in this country, I would prefer the common air-pump, which is a most effective instrument, but there are circumstances in which this machine might be adopted with advantage, and which may excuse the introduction of the foregoing.

Applied as a Ship's Pump.

The arrangement for this purpose is remarkably simple, being identical in principle with that just described, but different in detail. Fig. 3, is a plan and fig. 4 a vertical section, showing the valves. It will be observed that the general form is similar, but the construction of the valves, unlike the machine previously explained, is less complicated. First, the valve D is a single hinge valve, moveable as before, by a rod passing through the top of the pipe; secondly, instead of the valve at E, figs. 1 and 2, we have two valves marked

1 and 2, opening upwards, being placed on the top of pipes E, passing into the bilge; and, lastly, we dispense altogether with the valves in the branch pipes. Presuming I have made myself understood so far, let us suppose the ship at sea in a gale of wind, and leaking badly, and let the valve D be in the position shown, then the water will rush through the pipe A, pass through C, and out at the stern; then reverse the valve D, the water now flows through B, and at the same time we have the water in pipe C passing on by virtue of its own momentum, leaving a vacuum behind; when this takes place, the valve 2 will open and admit the water from the bilge to fill the vacuous space. On reversing the valve D, the operation is repeated, and so on.

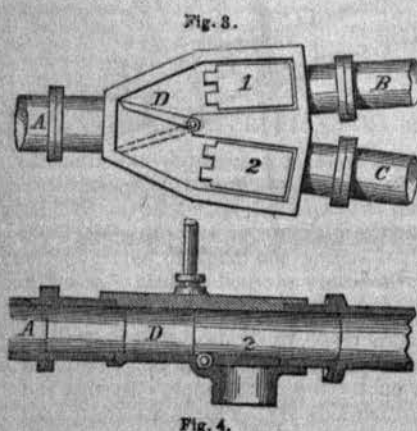
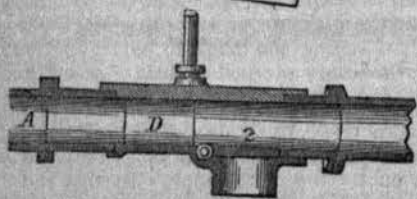


Fig. 4.



Let us now apply the formula, that we may acquire some conception of the power of the apparatus. I shall take that celebrated ship, the "Great Britain," with a length of keel = 282 feet; and as it is an object to keep the perforations made by the pipes as small as possible, they must be situated where the line of pipe meets the bend at bow and stern, as nearly as may be, at a right angle. This condition will diminish the effective length of the column to, say 250 feet, diameter of pipe = 12 inches, area 113 square inches, ship's load, draught 16 feet, immersion of pipe 11 feet, or 5 lb. pressure per square inch, speed of ship 12 miles per hour, 17.6 feet per second. Then

$$\begin{aligned} P &= 12250 \text{ lb.} & V &= 17.6 & R &= 5 \text{ lb. per square inch.} \\ G &= 32 & A &= 113 \text{ square inches.} \end{aligned}$$

$$\text{We have } L = \frac{12250 \times 17.6^2}{2 \times 32 \times 113 \times 5} = 105 \text{ feet.}$$

The contents of which is 82.3 cubic feet nearly. Again, our velocity is 1056 feet per minute, and if we reverse the valve D, when the water has passed on, only 52 feet, then we get the initial velocity 1056 feet, and the final velocity 528 feet, the mean of which is 792 feet. The machine, at this rate, might make 15 strokes per minute, but if one-third be deducted for friction, &c., or if we get 10 effective strokes (that is 5 to each pipe) we shall have 411 cubic feet, or nearly 12 tons of water thrown out of the ship every minute, equal to 180 pumps four inches diameter, and 11-inch stroke, going 30 strokes per minute, and if kept working during 24 hours requiring from 900 to 1000 men. This machine can be kept in operation during the same time by two men, and if desired may be made self-acting.

If the machine be worked at a low velocity, say four miles per hour, it will then discharge 127 cubic feet per minute, which is equal in efficacy to 60 pumps, worked by 300 men.

With respect to the machine as a substitute for the air-pump, it will be observed by referring to figs. 1 and 2, that on reversing the valve D, the branch pipe into which the water is flowing is nearly vacuous, that is, there will probably be a vacuum equal to 10 or 12 lb. per square inch (I speak of the Indicator), and the pressure being thus removed from the end of the column, the external pressure of the water and atmosphere will force the water through the pipe with a great increase of velocity. Suppose, for instance, that the length of the vacuous space (irrespective of that occupied by the water of condensation) was 10 feet, and the elasticity of the vapour filling this space equal to 1 lb. per square inch, then, according to the law which regulates the elasticity of gases under pressure, if we take half the length—five feet, and half the difference between the initial and final pressures—7 lb. per square inch, this will give the force tending to accelerate the velocity of the water through the pipe, viz., 7 lb. per inch acting over a space of 5 feet, and this power is available every time the valve D is reversed.

In the event of the vapour being of greater elasticity in the condenser, say 7 lb. per inch, still as it would tend to keep the water in motion in the after part of the pipe, it would reduce the quantity of resistance from 17 lb. per inch, as it stood in the calculation, to 10 lb., so that either view is favourable to the machine. In fine, a considerable amount of the power taken to produce the vacuum is again given out.

Figs. 5 and 6 show an arrangement which might be used advantageously to withdraw water from a cofferdam where there was a

Fig. 5.

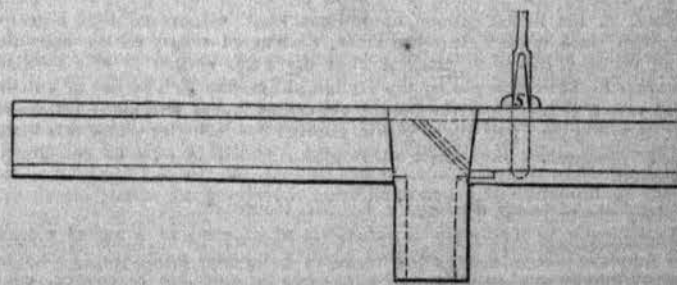


Fig. 6.

current, produced either by the natural stream of a river or the influx and efflux of the tide. The apparatus is supposed to be formed of four planks of wood nailed together, and a suction pipe constructed in a similar manner. On the top of this suction pipe there is fixed a

clack made of leather, with a plate of iron secured to the flap; and as a substitute for the hinge valve, formerly described, we have a piece of wood made to slide through the top, and in two grooves, one at each side of the pipe. The machine being immersed beneath the surface of the river, and a communication made between the suction pipe and the interior of the dam, it only remains to raise the slide S, and permit a current to be established inside of the main pipe or box; then by pushing the slide down, a vacuum would instantly be formed, which, as before explained, would elevate the water from the interior of the dam, to be expelled into the river when the slide was again raised.

I have erected a machine of this form; and as it can be constructed and put in operation in a few hours, and as it is both effective and costs but little, I recommend it to parties who have hydraulic works in progress, where the situation will admit of its being employed.

In conclusion, this machine is obviously applicable to the raising of water, or producing a vacuum, in every situation where we can command a fall or running stream; and experiment having proved it to be superior to the undershot water-wheel, for these purposes, whilst with this great power it combines simplicity, durability, and cheapness, in the highest degree, I am humbly of opinion that it is likely to be extensively employed, in which case, the foregoing description will not have been written in vain.

RAILWAY-CARRIAGE BREAKS.

At the last quarterly meeting of the Institute of Mechanical Engineers, held at Birmingham, Mr. J. G. M'Connell in the chair, the following communications were read:—

Mr. G. STEPHENSON, President of the Institute, "On a new Self-acting Break,"* a beautiful model of which accompanied the paper.

"The various accidents on railways arising from concussions and collisions (and especially the late accident at Wolverton) have induced me to draw my attention to the construction of a self-acting break, which I have for several years had in view, a plan and model of which I have had made, and now lay before the Society, with my description of its action and effects. When a railway train is moving at the rate of from 40 to 60 miles an hour, the momentum is so great that it cannot be stopped in any reasonable distance by the breaks at present in use; or if an axle-tree breaks, or any accident happen to the engine so as to prevent its progressing, the sudden shake causes the carriages to overturn each other, and those next the engine are almost certain to be crushed. In an accident of this kind, neither engine-driver, stoker, or guard can be prepared, and before there is time for any of them to put on the break at present in use, so as to be in the least degree effective, the collision or concussion has taken place. When the engine-driver shuts off the steam or applies his break on the tender, the self-acting break is immediately brought to bear upon every wheel attached to every carriage in the train so powerfully, if necessary, as to bring every wheel into the condition of a sledge. I think the train will be brought to a stand by this break in one tenth of the space in which it can be by the breaks at present used. My plan is as follows:—I attach a couple of spiral springs to the levers of the break of every carriage, and also connect them with the buffers, and if the carriage requires gentle breaking (which will always be the case when a train approaches a station), the engine-driver, by shutting off a portion of the steam, or applying the break gently, will have complete command over the train, without any of those violent uneasy motions, which are very frequent and excessively disagreeable to passengers; and as the guard is frequently compelled to apply his break so powerfully as to make the wheels slide on the rail, and cause a considerable amount of wear and tear on the tyre of the wheel, by which it becomes flat-sided, and makes the carriages uneasy, and creates a jumping motion on the rail. Suppose a train of carriages moving at the rate of from 30 to 40 miles an hour, and a signal is held out for the engine-driver to stop; the moment he shuts off the steam, the whole of the breaks are brought into instant application of sledging the wheels, which will be more effectual than fifty men applying the common breaks, as the mischief is frequently done before the guard is apprised of the approach of danger. It is frequently necessary for the trains to be backed into a siding. When this is required, the train will first have to be stopped, and in one minute the whole of the breaks can be disengaged from the buffers, as is shown in the model, and when the train proceeds they are again dropped into gear. The plan altogether appears so simple that any ordinary mind can easily understand the whole of it; and I think the cost of putting the breaks on each carriage would not exceed more than from 5*l.* to 10*l.* Any effectual plan for increasing the safety of railway travelling is, in my mind, of such vital importance, that I prefer laying my scheme open to the world, to taking out a patent for it; and it will be a source of the greatest pleasure to me to

* A railway break, answering a similar purpose as the one described by Mr. Stephenson, has been patented by Mr. Bunnet, and described in the "Journal" for 1842, page 72. —Ed. C. E. & A. Journal.

know that it has been the means of saving even one human life from destruction, or that it has prevented one serious concussion."—In consequence of Mr. Stephenson's absence, the invention was not discussed, it being agreed that a special meeting should be called to consider the subject.

The consideration of Mr. Buckle's experiments on fan blasts, now exciting considerable interest, was then resumed. The chief object of Mr. Buckle was to show that the present fan blasts were imperfect in construction and expensive in operation. He proposed, as the result of experiments extending over a period of nine years, to have a series of fans, revolving in such a way as that the blast of air thrown from one would be communicated to each. He also showed the advantages of having a large inlet-pipe. By these means he estimated that not only would the blast be stronger with less horse power, but it would also be uniform; thus improving the quality of the iron, as well as producing it at a cheaper rate.

DREDGE'S SUSPENSION BRIDGE.

SIR—I beg, in reference to an extract you made from a Calcutta paper, in the last number of your *Journal*, to observe that I published no statement in the *Mechanics' Magazine* that I have not documents and drawings by me to substantiate.

Bath, Aug. 23, 1847.

JAMES DREDGE.

REVIEWS.

Tables for the Calculation of Earthworks. By F. BASHFORTH, M.A.

In our last notice of Mr. Bashforth's tables, we explained to our readers the method of determining the volume of earthwork when the height of the slopes on either side was the same, and the calculation involved only integral numbers in feet and chains; we now propose to show how the tables can be applied to determine the amount of earth both in ordinary and side-long cuttings, when the heights contain decimal portions of feet. Suppose, as before, the slopes of the side-long cutting to be produced until they meet in some straight line below the formation level; then if the vertical sections of such a cutting be similar triangles, we can apply the tables to determine the quantity of earth excavated; all we have to do then is to determine the area of these triangular sections a chain apart, take the square root of the areas, and substitute them for the *a* and *b* of the tables. For the method of using the scale of proportional parts we shall quote the following example, given by Mr. Bashforth himself:—

"Suppose *a* = 37·68 *b* = 12·53.

By the general table {37·12} = 1595			
Place	37 on (A)	for	·6 we get 42
	opposite 12 on (B)		·08 " 5·61
Place	12 on (A)	for	·5 we get 24·9
	opposite 37 on (B)		·02 " 1·49

Therefore {37·68, 12·53} = 1669· nearly."

The mode of construction of the scale is so minutely explained by the author, that any illustrations of our own would be quite superfluous. In conclusion, we cannot but express a hope that this will not be the last time we shall have the pleasure of recording Mr. Bashforth's useful labours. It is not saying too much to assert that no other member of the profession possesses an equal amount of scientific knowledge with Mr. Bashforth; and we trust that gentleman will not allow the talent committed to his care to be idle. There is plenty of room, and plenty of occupation for men of science amongst engineers; and while we are willing to admit the paramount importance of a practical acquaintance with details, we must firmly declare that unless the engineer combines with that knowledge of facts a knowledge of principles, the lives of the public will be jeopardied whenever they are intrusted to the stability of his structures.

The Double Gauge.—Observations by Mr. R. STEPHENSON, on Mr. BRUNEL'S report on the Double Gauge.

The public were greatly indebted to the scientific labours of Mr. Robert Stephenson for opposing the fallacious reasonings of the advocates of the atmospheric railway system, in the height of its popularity—he has now, in a work recently issued under the above title, in a masterly manner laid the axe at the root of the double gauge system, recently promulgated and proposed to be adopted on the Oxford and

Rugby railway. He has in his report exhibited in their true light the great danger and difficulties attending such a project. We shall here briefly give Mr. Stephenson's reasons for the conclusions at which he has arrived.

Although Mr. Stephenson admits the possibility of laying an intermediate rail, he entirely disagrees from Mr. Brunel as to the number of crossings required. He states that on the 112 miles of the London and Birmingham line, 58 crossings are required, and where there is a mineral traffic a still larger proportion. Even on the Great Western no less than two crossings are allowed to the Slough station. Working out in detail Mr. Brunel's rough sketches, he shows that according to one plan there must be at each crossing two additional half switches, two additional crossing points, two additional pairs of overcrossing points, four additional gaps, and three additional meeting points. On another plan, two additional switches, two crossing points, two overcrossing points, six gaps, and four meeting points—all additional, to be passed over by trains of either gauge. On another, two automatic switches of dangerous construction, to be passed over by all trains—one of which being placed the wrong way, would meet all the trains in one direction—with two half switches, four crossing points, two overcrossing points, six gaps, and four meeting points—all additional, to be passed over by every train.

From this Mr. Stephenson argues that great difficulty and danger would be brought into railway transit, and that the increase of interruptions or gaps in the line would be as two to one in the present system. Mr. Stephenson concludes, 1st. That the mixed gauge system increases the complication very much, so as to be inadmissible. 2nd. That it increases the danger greatly. 3rd. That it increases the expense. His estimate of the increased expense per mile of a narrow gauge line added to a broad gauge line is 5,794*l.*, and of the increased yearly expense of maintenance of way and working, 500*l.* He calculates the gross capital cost as equivalent to 18,474*l.* per mile, while he denies that there is any equivalent advantage.

The drawings of points and crossings attached to Mr. Stephenson's report show the great complexity to which they have arrived in the progress of railways, and the great attention now required in their study. Members of the profession will therefore derive great advantage from these practical examples.

The Baronial and Ecclesiastical Antiquities of Scotland Illustrated. By R. W. BILLINGS and W. BURN. London: Blackwood, 1847. Part II.

The second part of this work illustrates the chapel of Holyrood, as the first part did the cathedral of Glasgow, and we can now recommend it with still greater confidence as worthy of support.

The Engineer's and Contractor's Pocket-Book, for the Years 1847 and 1848. London: Weale.

This work contains the usual very valuable information, and much additional matter that will be useful to the engineer; but we doubt the policy of leaving out the standing orders, which, in consequence of the alterations made this year, particularly interest engineers and surveyors.

REGISTER OF NEW PATENTS.

GAS RETORTS.

RICHARD WALKER, of Rochdale, Lancashire, cotton-spinner, for "Improvements in the apparatus for the manufacture of gas for illumination, which said improvements are also applicable to the manufacture of other products of distillation."—Granted January 26; Enrolled July 26, 1847.

The improvement is for preventing the choking of the ascending pipe, which conveys the gas from the retort to the purifier, by the accumulation and incrustation of tar and other carbonaceous matter, and consists in breaking the immediate connection between the inner surface of the retort and the ascending pipe, by causing the latter to project inside the retort about two inches, instead of its being flush with the upper side, which improvement allows free egress of the gas, and allows the tar as it ascends the sides of the retort, instead of passing up the pipe, to fall from the top, and accumulate on the bottom, and from thence it is easily removed.

GAS METERS.

THOMAS FRIEND DICKENSON, of Newcastle-upon-Tyne, share-broker, and JOHN FALKOUS, of the same place, gas engineer, for "certain Improvements in gas-meters."—Granted December 15, 1846; Enrolled June 15, 1847.

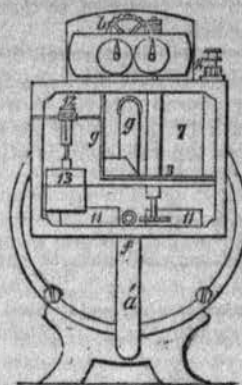


Fig. 1.

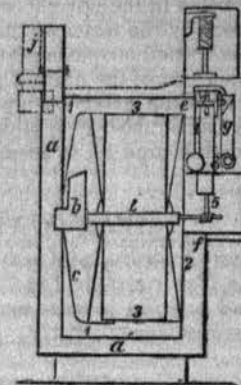


Fig. 2.

This invention relates to the construction of wet gas-meters, for preventing any tampering with the meter, by tilting it, to produce a greater flow of gas through the meter than indicated by the index. By the improved meter, if it be tilted, no gas will pass through it.

Fig. 1, is a front elevation of the improved meter, showing part of the interior, and fig. 2, a vertical section through the centre of the same; 1, 2, is the exterior case, within is the drum, 3, on a horizontal axis, 4, with an endless screw on the front end, which takes into a worm at the bottom of the vertical axis 5. The upper end of this axis 5, is also provided with an endless screw, gearing into the first wheel 6, of the index apparatus. The front plate 2, has a chamber, 7, in front divided by a partition 8, 9, 10; the space beneath the lowest part 8, is for water, it communicates with the water in the case 1, 2, through two openings 11, 11, the space above the partition 8, is divided into two, being for gas. An exit valve 12, with a float is fitted to an opening in a partition, so that if the water be at the proper level, the float will raise the valve to allow the gas to pass through the partition 10, to the exit-pipe; but if there be a deficiency of water, the float will descend and close the valve. On the top is a pipe 14, with a stopper for supplying water to the case under the partition 8, to the required level. If there be any excess of water it will overflow as hereafter explained.

The above parts are similar to the ordinary gas-meters; but the following, indicated by letters, vary. *a*, gas entrance-pipe communicating with the drum 3, by means of an elbow-pipe *b*, at the back of the case 1, and protruding through the additional end-plate *c*, of the drum. The pipe *b*, rises a little above the water in the case, for the purpose of introducing gas above the water: the pipe *b*, is introduced into the space between the additional end *c*, and the real end of the drum, as in common gas-meters, excepting it is at the back of the meter, instead of the front. *a'*, is a continuation of the pipe *a*, which descends at the back of the case 1, and is then continued at right angles along the bottom and again at the front, where there is a small hole at *f*. Any excess of water in the case 1, 2, will flow over the top of the pipe *b*, and pass down the pipe *a*, *a'*, and escape at the hole, *f*, so that no water will stand higher in the pipe *a*, *a'*, than the level of the hole *f*, and consequently no obstruction is offered to the flow of the gas from the pipe *a*, into the pipe *b*. But if the meter be tilted backwards, the water in the case will flow through the pipe *b*, and the escape hole *f*, being raised, in consequence of the tilting, the water will be retained in the pipe *a*, *a'*, at the same level as the hole *f*, and will prevent the gas passing through the pipe *b*, into the case 1, 2, and consequently the measuring will be suspended so long as the meter remains in that position.

The gas, which during the revolution of the drum 3, is discharged from the compartments into the upper part of the case 1, 2, passes through an opening *e*, into the space above the partition 8, and then enters through a protection-valve *t*, into an elbow-pipe *g*, and is then conducted into the space above the water in the lower part of the chamber 7. From thence the gas ascends through the valve 12, then through the exit-pipe *j*, which extends over the upper part of the case 1, 2, to the back of the meter; so that both the exit and entrance-pipes for the gas will be at the back of the meter.

If the meter be tilted forward, the water in the case 1, 2, will rise in the front part of the meter, within the space beneath the partition 8, 9, 10, and against the upright part 9, of that partition, where-

by the open end of the pipe *g*, will be closed, and the flow of gas stopped. The same is effected by the valve *i*, on the upper end of pipe *g*; the stem of the valve being jointed to a weighted pendulum *i'*, which closes the valve, on the meter being tilted forward, and stops the flow of gas. The pipe *g*, may be used without the valve *i*; or if the valve *i*, be employed, the lower end of the pipe may occupy a higher position in the upright side 9, of the partition, so that it will not be closed by the water on the meter being tilted.

There is a small air-passage at *k*, bored vertically through the nozzle at the upper end of the upright pipe 14, to permit air to escape from the interior of the meter when water is poured into it. A washer of leather or india-rubber is applied beneath the shoulder of the stopper, screwed on the pipe 14, to securely close the orifice of the pipe 14.

STEAM POWER FOR CRANES.

WILLIAM JOHNSON, of Grosvenor Wharf, Milbank, Westminster, gentleman, for "certain Improvements in machinery for raising or lifting and lowering weights or ponderous bodies."—Granted Dec. 1, 1846; Enrolled June 1, 1847. [Reported in *Newton's London Journal*.]

This invention consists in a peculiar adaptation of steam power to a drum barrel or cylinder, round which a rope or chain, for raising the weight, is passed. Rotary motion is given to the draught-barrel or pulley by a steam-engine; the outer end of its piston-rod being attached to a chain or rope, coiled round a winding-drum, of small diameter, fixed upon the axle of the draught-barrel.

Fig. 1 represents the apparatus in elevation, a portion of the frame being removed to show the internal parts of the machinery more per-

Fig. 1.

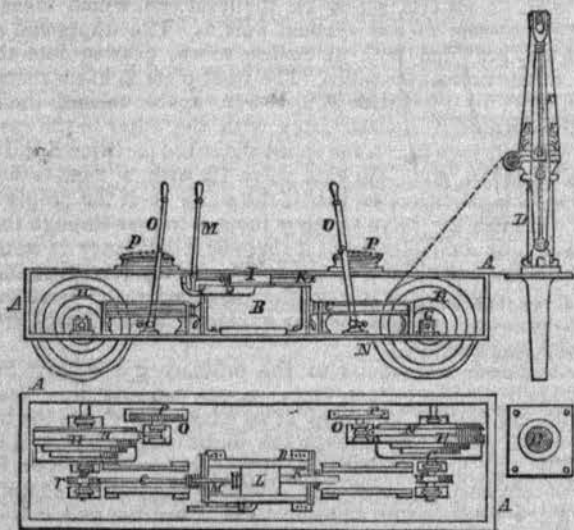


Fig. 2.

fectly; and fig. 2 is a horizontal view of the same. A, is a rectangular frame of iron, which contains and supports the machinery. It may be fixed firmly into the ground, or mounted upon wheels to admit of its being transported to different parts of a wharf or warehouse. In or near the centre of this frame A, the working cylinder of a steam-engine, B, is fixed,—its piston-rod, C, C, passing through both ends of the cylinder, for the purpose of rendering the machinery capable of raising and lowering heavy bodies, through the agency of cranes, fixed one at each end, when the machinery is required to be made double-acting, as it is supposed to be in the drawing, although but one crane is shown; but in a single-acting machine it is obvious that the duplicate parts of the apparatus may be dispensed with. D, D, are the upright parts or standards of a crane, with the usual jib E, and pulleys F. G, is a horizontal axle, turning in plummer-blocks, fixed upon the bottom of the frame. This axle carries a conical pulley H, which has several grooves formed in it, of different diameters, for the purpose of receiving severally the draught-chain or rope of the crane; the different diameters of the conical pulley being designed to effect different powers of draught. This pulley is enabled to slide laterally along the axle G, for the purpose of bringing either of the grooves into a line of coincidence with the leading pulley of the crane; and the pulley is confined to the axle, when it revolves, by a key passed through a notch in the pulley; or it may be by the axle in that part being formed square. Upon the axle there is also a smaller pulley I, fixed to the axle, and turning with it. This pulley is intended to

receive the coiled chain attached to the end of the piston-rod C, so that as the piston recedes in the cylinder the chain may draw the pulley I round, and with it the axle and the cone-pulley H. It will be seen that there is a cone-pulley H, connected to a draught-chain, at each end of the working steam-cylinder B; and that upon the axle to which this cone is keyed, there is affixed a small pulley I, with a chain connected to the end of the piston-rod, as before described,—thus making the machinery double-acting; that is, when a heavy weight is raising at one crane, a heavy weight may be lowering at the other crane.

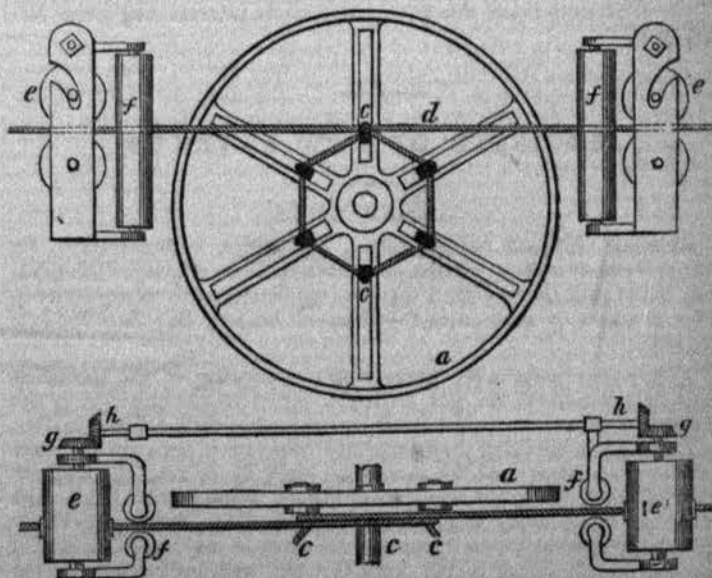
In working this machinery steam, at a high pressure, is to be provided in a boiler contiguous, from which the steam is to be conducted to the working-cylinder B, by a pipe K, shown as broken off in the drawing. The steam when passed through this pipe will occupy the steam-box L, and by the sliding of the valve within the box the steam will, in the usual way, be admitted into the cylinder at its ends, for the purpose of working the piston: the action of the slide-valve is produced by the hand of a workman applied to the lever M, so that the operations of the machine shall be always under command. Supposing that the piston in the cylinder B, is, by the pressure of the steam, passing from the right-hand end of the cylinder to the left, the chain connected to the piston-rod and to the pulley I, will draw round the pulley I, its axle G, and the cone-pulley H; and the draught-chain of the crane being attached to the periphery of the pulley H, as the pulley revolves the chain will draw up the weight suspended from the jib-head. Now, to prevent the raised weight, suspended from the crane, from descending, the pulley H must be made fast; this is effected by means of a break, formed by a band N, and lever O. The band being passed round the pulley H, as shown in fig. 2, the workman by moving the lever O, will cause the band N, to be drawn tight round the pulley and prevent its rotation; the lever being held in its position by a click or pawl, resting in the teeth of a ratchet P, as shown in fig. 1; and in lowering the weight the break may be gently released until the weight has reached its proper situation. The steam may be allowed to escape from the cylinder by a pipe Q, into the air; and it will be seen that a similar arrangement of parts being adopted to the reverse end of the machine, heavy weights may be either raised or lowered by their reciprocating actions.

WARPING VESSELS.

GEORGE BEADON, of Taunton, Somerset, a commander in the navy, and ANDREW SMITH, of Princes-street, Leicester-square, engineer, for "Improvements in warping or hauling vessels, which improvements are also applicable to moving other bodies."—Granted Jan. 21; Enrolled July 21, 1847. [Reported in the *Patent Journal*.]

These improvements consist in the use of certain machinery for warping or hauling vessels on rivers or canals, and which machinery, with slight modifications, is also adapted for propelling carriages on railways or common roads by ropes or chains.

The first part of the specification consists of a description of the improved apparatus or machinery for moving bodies on water, and



which, by the aid of the annexed engraving, will be readily understood. a represents the hauling apparatus or whelp-wheel, mounted

upon standard bearings, in the usual manner, and fitted to the deck of a vessel, with a horizontal crank-shaft passing through it; this shaft is firmly keyed to the whelp-wheel, and receives motion from two reciprocating steam cylinders, in connection with double cranks, on the driving-shaft; each arm of the wheel which is employed for the purpose of receiving the whelp, is furnished with a slot, diverging from the centre to the periphery of the same, and forming in all six radial guides or channels, in which six adjusting whelps, *c, c, c*, are to be fitted, and placed at equal distances from the central driving-shaft, and are made fast by wedges, which can be withdrawn at pleasure, and allow the circumferential or radial distance of the whelps to be increased or diminished, producing thereby corresponding rates of motion when required. By this arrangement the whelps form a reel, on which the coil of galvanised wire-rope or chain, *d*, is wound, and so grip the warping-line, which is fixed firmly at each end to some stationary object or holdfast upon the land or water; so that when the wheel, *a*, is caused to rotate, the vessel, by reason of the rope aforesaid, alternately embracing and leaving the whelps forming the reel, is propelled backwards or forwards, by motion being given to the wheel carrying the whelps in the required direction; *e, e*, are horizontal rollers mounted in cast iron standards, fore and aft of the warping-wheel *a*, and serve the double purpose of guiding the warp-line and keeping it tight on the reel; *f, f*, are two pairs of vertical guide-rollers, mounted on bracket bearings. On the axle of each of the lower horizontal rollers, *e, e*, a bevel-wheel, *g*, is mounted, which gears into others on the horizontal shaft *h, h*; the pair of bevelled wheels, *g, g*, at the forward end of the shaft *h*, is intended to be of a less speed than the aft pair, for an object hereafter explained. The friction of the warping-rope, as the vessel moves, will cause the rollers to revolve, and as the upper rollers, *e, e*, by their weight, press or nip the rope or chain against their under rollers, and the speed of the fore ones is less than the aft pair, the latter will have a tendency to take up the rope or chain quicker than it is given off from the reel, and thus keep it taut.

In order to allow one vessel to pass another on a single line of warping-chain or rope, it will be necessary to throw one vessel out of connection with the rope temporarily; for this purpose the rollers *e, e*, may be readily lifted out from their bearings, which will admit of the warping-chain or rope being thrown off from the rollers *e, e*, when required.

A further modification of the above arrangement is next described, which consists of a roller, mounted upon suitable bearings, having two smaller ones above it attached to the same framing, the upper ones being pressed down by means of screws or springs, or otherwise made to nip the chain or rope sufficiently, so as to prevent its slipping when the lower roller is caused to revolve by the steam-engine or other motive power employed in the vessel.

The next mode described by the patentees for applying such arrangements to locomotive purposes, consists of placing in the front of the engine the whelp-wheel aforesaid, and attaching it thereto, causing it to be driven by means of connecting rods from the crank-shaft; in other respects, differing but slightly from the ordinary construction.

The fourth part of this invention has reference to different modes of nipping the rope or chain, and consists first of three or more cylinders fixed to the arms or periphery of the whelp-wheel, which is placed across the vessel, with its guide-pulleys fore and aft; pins are inserted in the periphery of the wheel *a*, for the purpose of receiving the coil of rope or chain around it, and preventing its slipping; the cylinders, which are placed at equal distances apart, are supplied with steam at different intervals through the same shaft on which the wheels rotate, having suitable valves for that purpose; every cylinder so placed has a piston and piston-rod, and, when in operation, receives the pressure of steam on one side of the piston only, while on the other is fixed an elastic medium, such as a spring or otherwise suitable contrivance, the effect of which will be thus understood:—The rod of the piston, which in this instance forms the nipper, having a notched end for the purpose of holding the rope or chain, is pressed forward by the force of the steam acting behind the piston, and made to nip the rope or chain against the off flange of the whelp-wheel *a*, through which the rod on one side passes; when, upon the steam being condensed in the ordinary mode, the action of the spring being free to move, the piston-rod or nipper is again withdrawn and the rope wound upon the wheel. When the wheel *a*, having the warping rope or chain passing round, is employed for the purpose of propelling, it will be at times necessary, in order to ensure a firm hold for the rope or chain and prevent its slipping upon its drum or periphery, to resort to other means, such as a bar of iron or any other arrangement for pressing the rope or chain in the running groove against the sides of the flange, until another nipper or wheel is brought to bear

upon the rope or chain, alternately pressing and nipping the rope or chain during the revolutions of the wheel.

The application of vibrating-levers with sliding-rods is next described, for the purpose of pinching or nipping the rope; these levers are mounted on centres resting on the sides of the wheel, to the outer ends of which two sliding bars are attached, and pass in a horizontal direction through one flange of the wheel, so as to press upon the inside of the other, against which the rope is wound; the requisite action is communicated to them by means of a fixed cam, situated near the centre of the wheel, whilst the re-action is effected by springs, the cam pressing the sliding-bars by the motion of the lever against the rope, and the springs releasing them. Placed on the wheel are small boxes having springs, with a tendency to draw into their boxes the sliding-bar aforesaid, which, by being attached to one end of the vibrating-levers worked by the cam, keep the rope tight by throwing the hook or notch upon the same; thus enabling each bolt, nipping rod, or buffer (forced back against the chain in succession) to release its hold alternately as the wheels revolve.

The adaptation of the principle hereinbefore mentioned, when applied to steam tug-boats, consists in arranging the apparatus in the centre of the boat, and casing it in upon the top, that the central portion thereof may act as a bridge, and thereby offer sufficient resistance to the strain, at the same time enabling the steersman to perform his duty without any interruption from the warping line or rope.

Lastly is described the means employed for raising boats and barges from one level to another, and consists in forming at convenient distances along a canal, a number of inclined surfaces or banks crossing the stream, between which the water of different levels is confined; each bank so formed being at an angle of 45°, and having on its face trams or rails. The boats or barges on the lowest level, in order to be raised to a higher one, are mounted upon wheels for the purpose of traversing the rails; other boats or barges on the next level are then attached by means of ropes to the lower ones, and when the apparatus is put in motion from above by steam or other motive power, the lower boats or barges are drawn up the incline, and thus caused to pass from one level to another by the use of the hauling apparatus hereinbefore described.*

* An invention similar to this latter part has been adopted on the Morris Canal, U. S. America, and described in the Civil Engineer and Architect's Journal, for 1842, page 104.—Ed. C. E. & A. Journal.

ELECTRO COPPERING, GILDING, AND SILVERING.

LOUIS HYPOLITE PIAGET and PHILIP HENRY DU BOIS, of Wynnstreet, Clerkenwell, Middlesex, for "Improvements in producing ornamental surfaces."—Granted November 12, 1846; Enrolled May 12, 1847.

This invention consists of improvements in depositing metal, by the employment of a bath in the following manner, as shown in fig. 1. The bath consists of an earthenware vessel, *A*, with a similar plate *B*, perforated, and with one or more apertures *C*, to receive tubes *D*, and a long opening, *E*, in the centre, for suspending the model or electrotype plate.

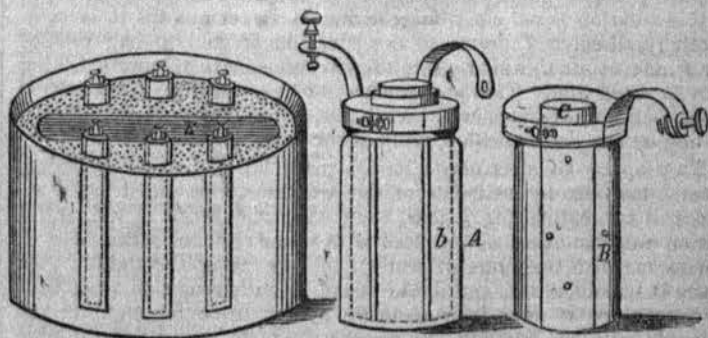


Fig. 1.

Fig. 2.

For electrotype plates the bath is to be filled with a solution of 14 lb. blue vitriol dissolved in 7 quarts of water, and when it is cooled put on the plate *B*, with some pieces of vitriol laid on the top; then fill the tubes *D* with a preparation consisting of 5 pints of water, ½ lb. common salt, ¼ pint of fresh human urine, and 6 drams sulphuric acid. The tubes to be filled up every six hours, until the third day, when they must be emptied and refilled, as before, till the deposited plate is as thick as desired. Care is to be taken that not a drop from these tubes falls into the bath.

The model to be used in the bath, either of gold, silver, or copper, is to have soldered on the back a piece of copper wire, for a conductor; and the model is to be well cleaned with plumbago and a brush, and its back fixed in wood, leaving only the required surface exposed. Take a piece of zinc, about five ounces, and fasten on a screw, then attach the copper wire to the screw, and place the piece of zinc in one of the tubes D, suspending at the same time the model through the centre hole, E, of the plate B, into the bath; when the plate is taken out of the bath, and taken off the model, it will exhibit a burnish polish or dead appearance, according to the preparation of the model; it will also be found to be good and pliable metal, bearing to be made several times hot without injuring or destroying the copy of the finest engine-turning or engraving.

Preparation for Silvering.—First dissolve 700 drams of sulphate of soda recently prepared in four parts of warm filtered water. Secondly, dissolve 25 drams of carbonate of soda (when for use with electric currents, but when to act by simple immersion, 75 drams are used) in a pint of warm filtered water. Thirdly, dissolve 31 drams of moist carbonate of silver. When these solutions are cold, mix the sulphate of soda and the carbonate of soda together, then add the carbonate of silver, and stir all well with a glass stick till the silver is well incorporated. This preparation is to be used cold.

Battery.—When electric currents are to be used with the above purposes, it is preferred to employ the battery shown in fig. 2, which is constructed as follows: *a* is a glass jar; *b*, a tube of charcoal; *c*, a porous vessel; and *e*, a tube of amalgamated zinc. In making small articles of silver, or of gold as hereafter explained, such as watch-cases, three such batteries connected together form a proper strength for the purpose; but for larger articles, more such batteries must be used. Into the vessel *a*, put nitric acid and water, mixed in equal quantities; the tube of charcoal, *b*, is introduced into such vessel, *a*, and the porous vessel, *c*, is introduced into the tube, *b*, and the liquid should then nearly fill the vessel *a*. Into the vessel, *c*, put a mixture of $\frac{1}{2}$ oz. sulphuric acid, 1 oz. common salt, and two pints of water. The copper bands, *d*, of the three or other number of batteries used are to be connected together, and these metal connections are to be made between the models which are introduced into the bath to receive precipitations thereon; the copper straps, *f*, are to be connected to each other, and the one from the last battery is to have a piece of platinum wire soldered at its end, and this platinum wire is to be dipped about half an inch into the liquor of the bath.

Preparation for Gilding.—First dissolve 375 drams of pure phosphate of soda in $4\frac{1}{2}$ pints of warm filtered water. Secondly, dissolve 50 drams of recently-prepared sulphate of soda in half pint of warm filtered water. Thirdly, dissolve 7 drams of perfectly dry chloride of gold in half pint of warm filtered water. Take the solution of gold and mix it with the solution of phosphate of soda, then add the sulphate of soda. Care must be taken that they are well mixed. This preparation is to be used warm, but not boiling. This bath is to be used with electric currents, preferring to use for this purpose the battery above described for silvering.

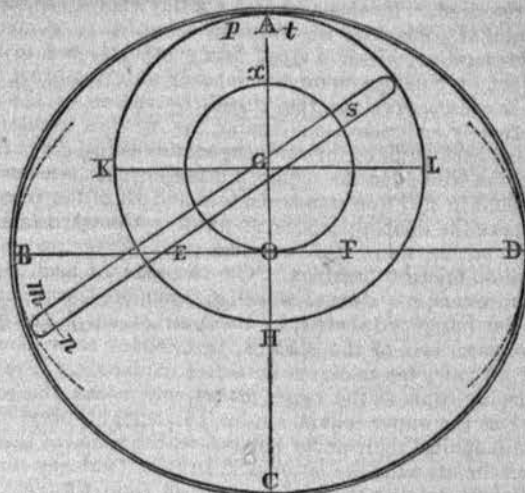
Preparation for Gilding by Immersion.—First dissolve 700 drams of pure pyrophosphate of potash in five pints of warm filtered water; if this solution is not clear, filter it and let it remain till it is cold. Secondly, dissolve 7 drams of dry chloride of gold in half pint of water, then pour this gently into the pyrophosphate of potash, taking care to stir it well. This preparation to be used warm. This bath is to be used in like manner to what has heretofore been done when gilding by simple immersion, without the aid of electric currents.

To prepare an electrotype model plate for gilding or silvering, after it has been in the hands of the workman, first, put it in the essence of turpentine for $\frac{1}{2}$ hour, then wash and brush it well, after which put it in nitric acid diluted with water ($\frac{1}{2}$ oz. of nitric acid of commerce with two pints of water), to take away the oxide; then place it in cold water, and again brush it with rouge to give brilliancy; place it next in fresh-made human urine for eight or ten minutes, and then again in cold water; the plate is now fit for gilding or silvering by the bath above described. By this process a coating of gold or silver will be obtained, which when taken from the bath will only require to be brushed with spirits of wine and rouge, and in less than half-a-minute it will be as brilliant as when taken from the model. It is not necessary to use the scratch-brush, or to burnish any part of the plate, which is always required after other modes of gilding and silvering, and which always injures fine engine-turning and engraving.

ROTARY ENGINES.

WILLIAM BREYNTON, of the Inner Temple, in the city of London, gentleman, for "certain improvements in rotatory steam-engines."—Granted January 21; Enrolled July 21, 1847. [Reported in the *Patent Journal*.]

This specification is accompanied by a diagram (see the figure) illustrative of the principle on which the rotatory engines are to be constructed. A, B, C, D, is an ellipse, described with foci, E, and F, half the major axis, or transverse diameter of which, is represented by O, B, = *a*, (a known number = 1.5904) whilst half the minor axis or conjugate diameter is represented by O, A, = *b*, (another known num-



ber = 1.5); the focal distance is represented by O, E, and O, F, = *c*, (= .524). A, K, H, L, is a circle described with centre G, and radius, G, A, which radius, = *d*, (= $\frac{1}{2}$ of O, A). X, Y, represents a circle described with centre, G, and radius G, O, = *e*, (= .5); the remaining parts will hereafter be more particularly described and alluded to; but it may be as well to observe that N, S, represents a piston passing freely through the centre of the circle, A, K, H, L, (and having a sliding motion in the direction of its length,) whilst *m*, *n*, is intended to show the thickness thereof. In an engine constructed upon the principle above shown, A, B, C, D, then would represent the outer iron case as it would appear in vertical section, and which case, therefore, would be of an elliptical form, although employed for a similar purpose to that part of an ordinary steam-engine known by the name of the cylinder; below, or at C, would be the foundation-plate, upon which the said elliptical case would have to be fixed. A, K, H, L, marks the place that would have to be occupied by a hollow cylindrical shaft or piston-rod (of considerable diameter), and which is placed at such a distance, it will be observed, from and above the centre of the elliptical case, A, B, C, D, as that the circumference of the said shaft or piston-rod shall come in contact with the inner surface of the elliptical case at the point, A, and at which would be the slide-valve so arranged, that the steam might be introduced into the elliptical case, say at or near to such point, A, or at *p*, when by acting upon the sliding-piston, N, S, it must, thereby, impart a rotatory motion to the shaft, A, K, H, L, and the steam ultimately would be discharged through an aperture or eduction-passage, somewhere near also to the point, A, or at *t*; or the steam might be introduced and allowed to pass off through the ends of the case, if found advisable. For reversing the engine, or causing the piston and shaft to move in a contrary direction, it would only be necessary to make the eduction-pipe available for the passage of the steam out of the cylinder, by altering the position of the cock or slide-valve, and in the usual way, the shaft, A, K, H, L, must pass through steam-tight stuffing boxes at each end of the case, and revolve in bearings in the upright frame attached to the foundation-plate. The sliding piston, N, S, will be rectangular, its breadth being equal to the distance between the ends or side-plates of the elliptical case, whatever that may be, and its length (as shown at N, S,) equal, or nearly so, to the shorter diameter of the same. This piston must slide through a slot or aperture in the shaft or piston-rod, so that whilst the rod moves in a circular direction, the sliding piston moving with it and through it, performs an elliptical course by reason of the pressure of its extremities against the inner surface of the case; and the ends of the piston, as the patentee observes, should be kept in close contact with such inner surface of the case by aid of metallic packings and of springs, the elasticity of the latter, by exerting a constant outward pressure against the former, serving to accomplish such object.

The shaft or piston-rod may be of any proportional part of the shorter axis of the ellipse, the longer axis being varied accordingly, and so that the correct principle of action may still be retained; but the proportion, which the patentee recommends as having been found to be most efficient in practice, is that the revolving shaft shall (as seen in the diagram) have a diameter of not less than two-thirds of the shorter diameter or minor axis of the ellipse, and which will make the longer diameter or major axis about 1.06 times such shorter diameter; for if the diameter of the revolving shaft or piston-rod be materially smaller than this, the figure of the case must either cease to be a perfect ellipse, and thereby become very difficult to bore, or else the increased length of the piston will involve the necessity of the metallic packing moving through a very considerable space, and which would be inconvenient.

MAKING ZINC AND GAS.

DANIEL TOWERS SHEARS, of Bankside, Southwark, for "*Improvements in the treatment of zinc ores for the purpose of producing zinc ingots, which improvements are applicable to the reduction of other ores and metals.*" (A communication.)—Granted January 19; Enrolled July 19, 1847.

The invention relates to making zinc from ores in combination with the making of gas for the purposes of light and heat by using a blast high furnace and anthracite, coke, charcoal, or other suitable fuel, and other metals may be made at the same time.

Fig. 1.

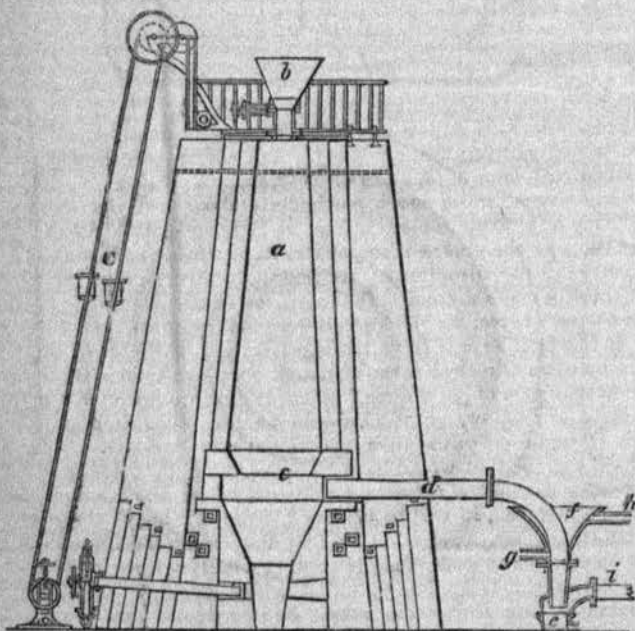


Fig. 1, is the section of the furnace and apparatus. The furnace *a*, is charged through a funnel *b*, at the upper part, there being slides to prevent the passage off of the gas which may be at the upper part of the furnace, the lower slide being closed when the upper one is opened at the time of introducing a charge; the upper slide being closed when the lower slide is drawn out to allow the materials to descend into the furnace. The materials for charging the furnace are raised by an endless chain *C*. If iron be contained in any of the ores or materials to be used (and such is found sometimes to be the case), then the lower part of the furnace is to be made suitable for tapping off the iron from time to time in precisely the same manner as iron furnaces have heretofore been constructed. No claim is made for the construction of such furnaces, but only the mode of making zinc therein. At the upper part of the boshes *c*, the furnace is contracted under which the gas and the vapours of zinc accumulate and pass off through the pipe *d*, into the receiver *e*. The pipe *d*, passes through the vessel *f*, which has a flow of water constantly through it, passing into it by a pipe *g*, at the lower part and off at the pipe *h*, at the upper part. Or oil may be used in place of water, in which case, as long as the oil is kept below its boiling point, it will indicate that the gases are not carrying off zinc vapours, and the receiver is kept sufficiently heated to prevent the zinc solidifying, which it is preferred to do by

a gas burner supplied with gas from the apparatus, and there is a tap hole at the lower part of the receiver to draw off the zinc. The gas passes from the receiver through a pipe *i*, in order to convey the gas to be burned for any desired purpose, whether for light or heat, and it may be used for roasting the ores before they are used by placing the same in suitable ovens or retorts, and heating such retorts with the gas. This furnace is similar to that described by Mr. Constable, in his patent for making gases from anthracite and other fuel in blast or high furnaces, and would, if no ores or matters capable of yielding zinc be introduced with the fuel simply produce gas, but by introducing roasted zinc ores with the fuel from time to time, zinc will be made and be received into the receiver, thus beneficially employing the heat of the furnace. The quantity of ore introduced into the furnace may be varied according as it is desired to make a large or a smaller quantity of zinc. Any quantity up to one part by weight of roasted ore to three parts of the fuel employed is recommended. Iron or other ore may be introduced and treated with the zinc ore.

ELECTRIC TELEGRAPHS.

ALFRED BRETT, of Holborn-bars, gentleman, and GEORGE LITTLE, of High-Holborn, electrical engineer, for "*Improvements in electric telegraphs, and in the arrangements and apparatus to be used therein and therewith, part of which improvements are also applicable to time-pieces, keepers, and other useful purposes.*"—Granted Feb. 11; Enrolled Aug. 11, 1847. [Reported in the *Mechanics' Magazine*.]

The improvements claimed under this patent are ten in number. We shall give the claims in the words of the inventors; and such explanations of them as may be necessary to show their general scope also nearly in their own words.

First Claim.—"We claim, as an improvement in electric telegraphs, the use of a ring, or piece of metal, partially magnetised, in combination with a reel or coil of wire, whereby and wherein the electric current so acts, that the motions take place in a direction transverse to the axis of the coil, and parallel, or nearly so, to the planes in which the wire, constituting the coil, lies."

The electric fluid is made to pass through a number of coils of fine wire, properly coated or covered with silk, or other suitable non-conducting material; which wire is wound round a flat reel, or reels, of ivory, or other suitable material. The ends of these fine wires are alternately brought into contact with the galvanic battery, by suitable arrangements, whereby the current is made to act on and give motion to a partially magnetised ring, or piece of metal, suspended and moving on a fixed centre in a plane parallel to the side, or face, of the flat reel, about which the wire is coiled; that is to say, parallel to the planes in which the wire is so coiled; the motions of this partially magnetised ring being communicated to an indicator, or indicators, whose motions in connection with a peculiarly arranged dial-plate with symbols thereon, may be employed to designate letters, figures, or other conventional signals, and transmit intelligence by means of electricity.

The patentees say, "We wish it to be perfectly understood, that although we have described the foregoing, by the application of circular coils of fine wire prepared as above described, wound round or upon a flat circular reel or reels, in conjunction with a flat metallic partially magnetised ring, moving parallel with such coils of fine wire for the giving motion to inductors, by which letters, figures, or other conventional symbols are designated; the same motion can be obtained, and the same principle applied, by other modifications and arrangements, but we prefer using and adopting the arrangement above described."

Several exemplifications of such modifications are afterwards given.

Second Claim.—"We claim, as an improvement in electric telegraphs, an indicator, or indicators, deriving motion respectively from a current of electricity transmitted through a coil arranged and acting on a partially magnetised ring or piece of metal, as above described, and the adaptation of such motions to communicating intelligence between distant places."

Third Claim.—"We claim, as an improvement in electric telegraphs, the adaptation of an indicator or indicators to a dial-plate, constructed and arranged as described."

On the dial-plate are two vertical columns containing numerals from 1 to 25. The centre of the plate is retained for the symbolic arrangement of letters and figures by which the whole of the letters of the alphabet can be designated. When the indicators are in a state of rest they are in an angular position; but when put in action they move to a position nearly vertical, but are prevented from passing the vertical line by a pendant bar. In transmitting a signal or

signals the letters of the alphabet are designated by single or repeated motions of either of two indicators (right and left hand), or both in conjunction. Thus the letter A, which is placed opposite to fig. 1, is indicated by one motion of the left-hand indicator; the letter B, which comes opposite to fig. 2, by two motions of the same indicator; the letter E by four motions, two left and two right; and so on.

Fourth Claim.—"We claim, as an improvement in electric telegraphs, the working two indicators, so as to give the requisite motions by means of a single handle constructed and arranged as described."

Fifth Claim.—"We claim, as an improvement in electric telegraphs for giving audible signals, the use of a ring or piece of metal, partially magnetised, in combination with a reel or coil of wire, as above described, whereby and wherein the electric current so acts that the motions take place in a direction transverse to the axis of the coil, and parallel, or nearly so, to the planes in which the wire, constituting the coil, lies, and actuate suitable apparatus for giving such audible signals."

A bell or gong is substituted for the dial-plate and indicators, and the signals expressed by striking one, two, or more successive blows on the bell or gong, which is effected by wheelwork, for which no separate claim is made.

Sixth Claim.—"We claim, as an improvement in electric telegraphs, the use of an apparatus for conducting the atmospheric electricity to the earth, in which the two semi-spheres of the lightning-conductor, as usually constructed for that purpose, may be adjusted to or from each other, as circumstances may require."

In lightning-conductors, as ordinarily constructed, there are two metal plates (say A, A'), which are fixed to and kept apart by blocks of ivory, and two semi-spheres (c and c'), which are made fast, one to each plate. The improvement here consists in making the semi-sphere c fast to the plate A (as usual), but attaching the other by a screw to the plate A', "by which means, and by the aid of a regulating screw-nut, the semi-sphere of metal may be brought either closer or farther distant from the semi-sphere c, as may be rendered necessary by the expansion or contraction of the instrument, or other circumstances."

Seventh Claim.—"We claim, as an improvement in electric telegraphs, the insulator, and stretching of the long circuit wires upon and by means of an insulator, bell-shaped in the interior, so as to prevent the rain establishing a circuit for the electricity from the wire to the support upon which the insulator is affixed, and so shaped on the exterior as to admit of a stretcher, constructed as described, being applied at pleasure, to stretch the long circuit wires from insulator to insulator."

These insulators are to be made of glass, earthenware, porcelain, or metal.

Eighth Claim.—"We claim, as an improvement in electric telegraphs, a deflector, constructed and arranged as described, in combination with an earth-plate to each instrument, whereby the electric current may be diverted, and the instruments insulated in such manner as to allow the instruments at two or more stations on a long line to communicate with each other, independently of the other stations."

Ninth Claim.—"We claim, as an improvement in electric telegraphs, the use of the apparatus called 'the hydraulic battery,' in which the acid to the sand, or other retainer of moisture, is supplied from above, drop by drop, and escapes from below, drop by drop, so as thereby to keep up continuously a percolation through the sand, or other retainer of moisture, and, by such percolation, carry off the sulphate of zinc, and prevent its becoming crystallized on the plate; and we claim the said hydraulic battery, both as an improvement in the working of electric telegraphs, and as applicable to the working of time-keepers or clocks, where electricity is employed as a motive power, and for other purposes in which a steady uniform current of galvanic electricity is required."

Tenth Claim.—"We claim for time-keepers, in which electricity is a moving power, the use of a ring or piece of metal, partially magnetised, in combination with a reel or coil of wire, as above described, whereby and wherein the electric current so acts that the motions take place in a direction transverse to the axis of the coil, and parallel, or nearly so, to the planes in which the wire, constituting the coil, lies, and are adapted to suitable apparatus for measuring and indicating time."

As electric time-keepers require but a small power for keeping their pendulums in motion, "a sufficient current may be obtained from two series of any one kind of metal (for which purpose zinc

or iron is the most economical), buried in the earth;" and "when zinc is used for the series, the supply of electricity may be augmented by surrounding one set of the plates of the series so employed with a solution of ammonia."

IMPROVED EXPANDING DIE

FOR MAKING DRAIN-TILES, CONDUITS, TUBES, CHIMNEY-POTS, AND OTHER ARTICLES MOULDED IN CLAY.

Registered by JOSEPH SALT, Brick-Maker, Uxbridge-Common, Middlesex.

The advantages of the improved die are, that with the same machine, much larger pipes and tubes may be made than heretofore. The improvement is shown in the section, fig. 1, which consists of

Fig. 1.

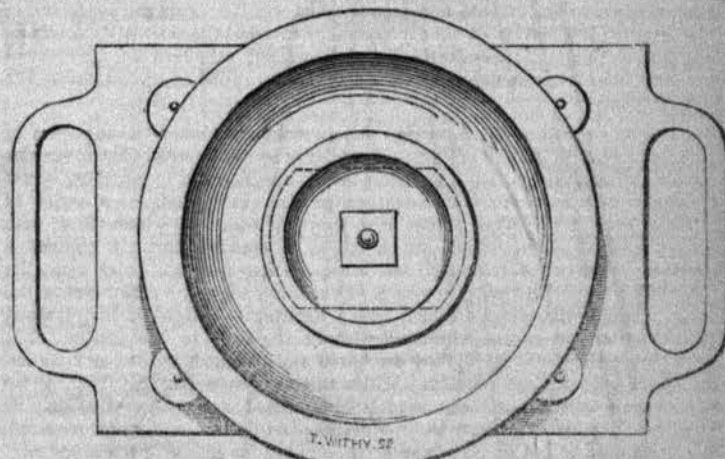
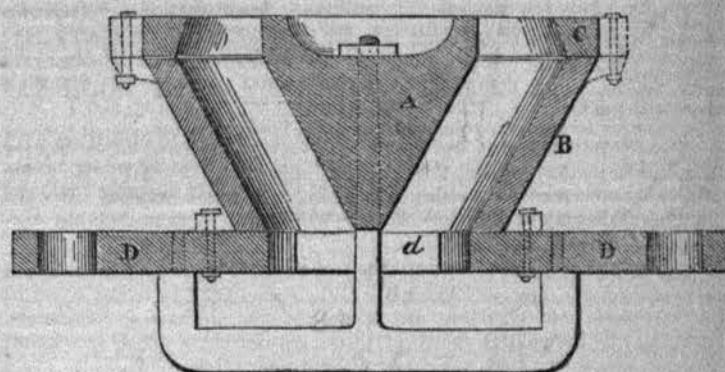


Fig. 2.

three parts: A, the centre piece, B the expanding tube, and C the die, to be made of iron, brass, or other suitable material.

The centre piece, A, is secured to the plate D by a spindle, and the external expanding tube B is also secured to the plate D by screws or bolts, and the die C is secured to the expanding tube by screws or bolts.

The clay to be moulded is forced through the aperture, d, of the plate D, and then between the centre piece A, and the expanding tube B, and out at the aperture C.

Fig. 2 shows the application of the expanding die for making circular tubes or pipes.

NOTES OF THE MONTH.

Railway Lift Bridge.—In last month's *Journal* we gave Mr. Rastrick as the engineer who designed the bridge; we have since been informed that it was designed by Mr. Hood, the resident engineer of the Brighton railway, and that some alterations have been made in the design.

An "Architects', Builders', and General Fire and Life Insurance, &c., Company" is about being established; already a preliminary meeting has been held, and an "ad-interim committee" formed. Among the names we see Mr. George Smith, Mr. Donaldson, Mr. Salvin, Mr. Sidney Smirke, and several other architects and builders.

University College.—The classes of Engineering and Architecture at University College have been rendered more complete by the recent appointment of Eaton Hodgkinson, Esq., as Professor on the Strength of Materials, and on Machinery. The lectures to be given by this competent experimentalist will include important results not previously given, and the theory will be illustrated by a description of a great number of original experiments upon most of the materials used in construction, such as cast and wrought iron, building stones, timber, &c., and the results of which have not been published. The distribution of prizes occurred on the 1st of July, Sir H. De la Beche being in the chair. First year's course:—*Fine Art*: Charles Poland, 1st prize and 1st certificate; T. Watts, 2nd prize and 2nd certificate. *Science—Construction*: H. Darbishire, 1st. prize and 1st certificate; Charles Poland, 2nd prize and 2nd certificate; T. Watts, 3rd certificate. Second year's course:—*Fine Art*: W. Tarne, 1st prize and 1st certificate; G. B. Smith, 2nd prize and 2nd certificate; J. W. McKenzie, 3rd certificate. *Science—Construction*: G. P. Boyce, 1st. prize and 1st certificate; W. Tarne, 2nd prize and 2nd certificate; G. B. Smith, 3rd certificate.

The Royal Italian Opera, Covent Garden, has now closed, and the results of the season, while we hope they have given every encouragement to the lessee, have fully responded to the exertions of the architect. The arrangements for hearing, seeing, ventilation, and accommodation have been perfect, and have given a good example of the progress of comfort in public buildings.

Kew Gardens.—The works at these gardens are proceeding, and Sir William Hooker seems determined to carry out a botanic garden, which shall be the finest establishment in the world. The grand palm-house is in a forward state, so far as the frame-work is concerned, but we doubt whether the house will be in a fair state for opening before 1849. A small museum has been built, as a Museum of Economic Botany, which will in time rival the Museum of Economic Geology.

The New Parliament is now filled up. It includes many parties connected with the railway interest. Mr. Robert Stephenson and Mr. Locke represent the engineers; Mr. W. Cubitt and Mr. S. M. Peto, the railway contractors. What may be the political merits of these new members we do not know, but as practical men they will not be without their value.

Damp Walls.—Dr. Murray recommends when damp walls proceed from deliquescence, in the case of muriate of soda, &c. in intimate combination with sand in the mortar, it is only necessary to wash the wall with a strong solution of alum. This converts the deliquescent salt into an efflorescent one, and the cure is complete. Or alum may be added to the plaster in the first instance.

Portable Cannon.—The American papers make mention of a new sort of cannon, invented by a Mr. Fitzgerald, which is so constructed that it may be carried by hand or on horseback over mountains, forests, or marshes, where an ordinary cannon would be altogether useless. It consists of a series of circular perforated plates of the best wrought iron, $\frac{1}{4}$ to $\frac{1}{2}$ inch thick, with well planished faces, which are arranged in contact, and are connected together by wrought iron rods or bolts, passing through holes near the periphery; the bolts having strong heads at one end, and a screw nut at the other, whereby the plates are held firmly together. Several of the plates at the breach are, of course, solid, and without the hole in the centre. The series being thus connected, they are bored and polished inside, and turned off to the proper shape outside. While this cannon is stronger than those of common cast iron, it can readily be dissected, and each section may be shouldered by either pedestrian or equestrian artillerymen, and when required, the parts may be put together and secured ready for action in ten minutes.

A Wire Suspension Bridge is now erecting over the Ohio, which will be the largest structure of the kind in the world, having a span of upwards of 1,000 feet, whereas that of Fribourg is but of 800 feet.

A Railway Club for engineers, architects, parliamentary agents, and solicitors, is proposed to be established in the vicinity of the Houses of Parliament.

The Revue du Havre states that a young chemist of that town has invented a system of lights for ports and coasts, consisting of a thick globe of glass, in which is enclosed a preparation giving a light like that of the moon, and the cost of which for one year will not exceed a franc.

Improvements in Gun-Cotton.—Mr. Coathupe recently forwarded to the Chemical Society two specimens of gun-cotton, with a view to illustrate the greatly increased explosive effects that are to be derived from a subsequent immersion of the gun-cotton, when properly prepared in the ordinary way, in a saturated solution of chlorate of potash. "Having experimented with solutions of nitrate of ammonia, nitrate of potash, nitrate of soda, bichromate of potash, &c., for the purpose of increasing the explosive properties of this interesting substance, I can affirm that none of the results will bear the slightest comparison with those obtained from the solution of chlorate of potash, either in rapidity of ignition, or in intensity of flame. The process adopted for preparing the enclosed specimens was as follows—viz.: into a mixture of equal measures of strong nitrous acid, and of oil of vitriol, spec. grav. 1.845, the cotton was immersed and stirred with a glass rod during about three minutes, it was then well washed in many waters and dried; a portion of it was then soaked for a few minutes in a saturated solution of chlorate of potash, well squeezed and dried."

New Fulminating Powder.—M. Sobrero in a paper to the *Academie des Sciences*, Paris, described what he calls *mannite nitrique*; viz., the substance called mannite obtained from manna, honey, &c., and treated by nitric acid. The *mannite nitrique* or fulminating mannite, explodes under the blow of the hammer with the same violence as fulminating mercury, and produces in its decomposition sufficient heat to ignite gunpowder. M. Sobrero has prepared capsules in which, instead of fulminating mercury, is placed a little nitric mannite crystallized in alcohol, and discharged a fowling-piece with them several times with the same certainty as with the ordinary capsules.

LIST OF NEW PATENTS.

GRANTED IN ENGLAND FROM JULY 24, TO AUGUST 23, 1847.

Six Months allowed for Enrolment, unless otherwise expressed.

John Platt, of Oldham, Lancashire, and Thomas Palmer, of the same place, for "certain Improvements in machinery or apparatus for making cards, also for preparing and spinning cotton and other fibrous materials, and for preparing and dressing yarn, and weaving the same."—Sealed July 24.

Charles De Bergue, of Arthur-street, West, City, for "Improvements in buffing and traction apparatus, and in springs for railway and other carriages."—July 26.

Alfred Ceal, of Aldgate, manufacturer, and Henry Bear, of New-road, manufacturer, for "Improvements in the manufacture of tobacco."—July 28.

Edward Ryan, of Park-place, Bayswater, Middlesex, for "Improvements in consuming the smoke and economizing the fuel of steam-engines, breweries, and manufactories generally."—July 28.

James Morison, of Paisley, shawl manufacturer, for "Improvements in applying power in propelling or moving carriages, and in giving motion to machinery."—July 29.

Joseph Paul, of Thorp Abbott's-hall, Norfolk, farmer, for "Improvements in cutting or forming drains in land, and for raising subsoils to the surface of land."—July 29.

Francis Starr, of Warwick, for "a new jet for the delivery of water and other fluids, which he styles the 'Protean Jet.'"—July 29.

William Baines, of Norwich, Inspector of railways, for "Improvements in the manufacture of parts of railways, and in the bearings of machinery, and in apparatus used in constructing railways."—July 29.

Alfred Vincent Newton, of 66, Chancery-lane, mechanical draughtsman, for "an improved kiln, or oven, for firing porcelain and other similar ware."—July 29.

William Phillips Parker, of 48, Lime-street, City, gentleman, for "an improved mode of manufacturing cigars."—July 29.

George Withersell, of New York, America, for "Improvements in manufacturing or working iron for various useful purposes."—July 29.

Stopford Thomas Jones, of Stamford-street, Surrey, for "Improvements in steam-engines, and in machinery for propelling vessels."—July 29.

John Hastie, of Greenock, Scotland, engineer, for "Improvements in the application of steam power to turn certain kinds of mills or machines with a continuous rotary motion."—July 29.

Hector Sandeman, of Tullock Bleachfield, in the county of Perth, bleacher, for "certain Improvements in the materials and processes employed in dressing, cleaning, scouring, and bleaching certain textile fabrics, and the materials of which such fabrics are composed."—July 31.

Theodore Fletcher, of Birmispham, brass-founder, for "an improved manufacture of speculums for various purposes."—August 3.

John Yule, of Sanchiehall-street, in the city of Glasgow, practical engineer, for "certain Improvements in railway chairs used on railways, and in fixing the same."—Aug. 3.

Joseph Bourne, of Derby Pottery, in the county of Derby, for "Improvements in the construction of kilns for burning stone ware and brown ware."—Aug. 4.

Arthur Boyle, of Birmingham, umbrella-frame maker, for "Improvements in the manufacture of buttons."—Aug. 4.

William Broadbent, of Manchester, for "Improvements in the manufacture of paper."—Aug. 5.

James Simister, of Birmingham, manufacturer, for "Improvements in the manufacture of stays and belts."—Aug. 5.

Thomas Birchall, of Ribbleson, in the county of Lancaster, for "Improvements in folding newspapers, and other papers."—Aug. 5.

Benjamin Bailey, of Leicester, machine-maker, for "Improvements in the manufacture of knitted fabrics."—August 6.

Edward William Eaton, of New Windsor, Berks, bachelor of medicine, for "certain Improved machinery for preventing accidents on railways."—August 19.

Osborne Reynolds, of Dedham, Essex, clerk, for "Improvements in making hop-poles, bundles, fencing ropes, baskets, or wicker-work, and other similar articles."—August 19.

William Bacon, of Bury, in the county of Lancaster, engineer, for "certain Improvements in steam-engines."—August 19.

William Eaton, of Camberwell, Surrey, engineer, for "certain Improvements in raising water and other liquids from one level to another."—August 19.

Orlando Brothers, of Blackburn, in the county of Lancaster, for "certain Improvements in the method of manufacturing retorts, and in the machinery or apparatus connected therewith."—August 19.

Archibald Tarries, of Preston, in the county of Lancaster, gentleman, for "Improvements in propelling carriages on common roads."—August 19.

Francois Augustus Renard of 40 Rue du Rocher, Paris, merchant, for "Improvements in preserving and colouring wood."—August 19.

James Webster, of Sneinton, in the county of Nottingham, engineer, for "an atmospheric buffer, to be applied to carriages and other vehicles travelling on railways."—August 19.

Alme Boura, of Rathbone-place, Middlesex, dyer and scourer, for "Improvements in extracting colouring matters."—August 19.

Alexander Speld Livingstone, of No. 7, Bridge-place, Lewisham, Kent, civil engineer, for "certain Improvements in the construction of locomotive engines intended to be used on railways."—August 21.

Thomas Dawson Praday, of the Freemason's Tavern, Great Queen-street, Middlesex, cook, for "certain Improvements in apparatus for reducing vegetable and other substances to small particles."—August 23.

THE CARLTON CLUB-HOUSE.

(With an Engraving, Plate XV.)

Since Mr. Smirke chose to forego the opportunity of exhibiting a production of his own, under such peculiarly advantageous circumstances as the occasion afforded, we are, for several reasons, very glad that for a work of reproduction he has gone to the example he has done. Independently of its intrinsic merit, we welcome that composition of Sansovino's as being likely to disabuse us of many prejudices,—although prejudices are apt to be so dreadfully obstinate and inveterate, that it may be questioned if even ocular demonstration will help to correct them. The Library of St. Mark at Venice,—of which, we presume, our readers are fully aware that the new façade of the "Carlton" is a direct copy, the original design being so well known by engravings of it in various architectural publications,—is so admirably contrary to all rules and all systems of the orders, as quite to confound them, and to nonplus that plodding sort of criticism which speaks according to book, orthodoxly enough, of course, but sometimes very stupidly. Had Mr. Smirke himself ventured to deviate in the same degree, or even half as much, from "approved recipes" for the orders, he would most assuredly have been taken to task by small critics for his extravagant licentiousness,—would perhaps have been put into the same category with Borromini, at least have been sneered at by the fribbles, for his conceit in presuming to make so exceedingly free with the established and only legitimate proportions of the ancient orders. To one who is acquainted with the orders only formally,—who knows them only by rote, as a schoolboy does his grammar, Sansovino's treatment of them must appear most extravagant, and little less than detestable; to the eye of an artist, on the contrary, it will show itself to be truly admirable, because highly effective;—and what, let us ask, is the purpose and object of architecture as art, except to produce effect?—since, take away that, and it becomes mere building, than which common-sense, if we are to abide by mere common-sense, demands no more.

In Sansovino the artist predominated over the architect,—that is, over the regularly-trained one, he being less attentive to direct authority and precedent—as far, at least, as the orders are concerned—than to artistic sentiment and effect. He* was more of the sculptor, or we may say of the artist, than the mere architect. As if for the purpose of exemplifying that line of Pope's, which says :

"And snatch a grace beyond the rules of art,"

he snapped his fingers at rules, and proportioned the entablature of the Ionic or upper order, rather to the entire elevation than to the columns themselves, it being, in fact, somewhat more than half the height of the latter, in bold defiance of the regulations laid down by such exemplary martinets as Messrs. Vitruvius, Palladio, Vignola, and Co. In palliation of this enormity, it is alleged to have been in a manner forced upon him by the necessity, at least desirableness, of making his building agree in height with the adjoining Procuratie Vecchie in the Piazza di San Marco. Yet as no such consideration can possibly have influenced Mr. Smirke, it may be presumed that he adopted the license for the sake of the happy artistic effect attending it, knowing also that he himself was well shielded from the reproach of desperate innovation and disregard of all system, since he has only adhered to his precedent for it.

Besides serving as an excellent lesson against narrow priggish systems respecting proportions—which some have laboured to reduce to the "rule of thumb,"—such an example as Sansovino's, and as here carried out by Mr. Smirke, may be efficacious in correcting that excessive tameness and penuriousness in architectural design which we have been wont to dignify to ourselves by the flattering epithets of "chaste" and "simple." It is true, thanks in a great measure to Mr. Barry, the miserable "starvation style"—more intolerable perhaps than even the mere "hole-in-the-wall" style—has been brought into disrepute; still, some specimens of bolder, freer, and more copious modes of decoration than we have hitherto been accustomed to in modern† architecture, are desirable. We need something too to correct our taste for that flashy and frivolous mushroom sort of design which puts a showy barrack-looking front to a mile-long range of houses, and then dubs such brummagem a "Terrace."

Not very many years ago,—when such truly prosaic buildings as Stafford-house were looked upon almost as architectural marvels, and as indicating

* For some account of him we refer our readers to what can be more easily referred to than Temanza, the second series of Gallahaud's Ancient and Modern Architecture, accompanying the description of the very edifice which has now been repeated in Pall-Mall.

† We here employ the term "modern" in contradistinction from mediæval architecture and imitations of it.

nearly a seven-league-boot-stride forward in taste—the idea of such a façade as is the new portion of the Carlton Club-house, would have been deemed most startlingly extravagant. It certainly does make the original Club-house, which still stands by it entire and intact, cut a more dowdy and dismal figure than ever. The contrast between the two is positively curious, and worth being recorded by the pencil, ere the first-mentioned structure be removed to make way for the completion of the other. Not the least curious circumstance of all is that two such strongly antithetical and antagonistic tastes should be exhibited in the works of two brothers, who most assuredly do not at all fraternise in their architectural sympathies. The contrast presented by the old (although not very old) and the new Club-house may, besides, be taken as an index of the revolution in architectural taste generally, for perhaps neither would Sir Robert venture to propose such a design now, nor would Mr. Sydney Smirke have thought of bringing forward Sansovino in the days of architectural purity, innocence, and water-gruel. Sir Robert's work will, of course, be very shortly expunged; not so, however, that of Soane in the adjoining ducal residence, unless his Grace of Buckingham should now be spirited up into contributing his share towards the architectural écat of Pall-Mall, by giving his mansion a new façade in aristocratic palazzo costume, to which latter it makes no pretensions at all at present, although when first erected it was perhaps considered both ducal and dignified enough. Whether that be ever done or no, the ducal Buckingham-house in Pall-Mall will be less shamed by comparison with the new Carlton, notwithstanding that it is in immediate juxtaposition with it, than the royal Buckingham-palace in the Park, the building added to the latter being a contemporary work. Sansovino was surely wanted there,—at least might have been consulted on that occasion.

With regard to what Mr. S. Smirke is doing in Pall-Mall, we could wish that as the design is so notoriously a copy, he had adhered more strictly to the original in one or two particulars wherein he has now deviated from it, not at all for the better. Some, indeed, there are which called for correction,—the balustrading in particular, for it is not of the best proportions; and the balusters themselves are, at least in our eyes, decidedly ugly, and seem designed rather for wood-work than stone. But the omitting the moulded archivolt to the arches within the lower order is assuredly no improvement, because it does away with that attention to keeping and consistency of character with which Sansovino treated both his orders in that composition, assimilating them as to general style. The Doric is of professedly ornate, or we may say florid, description. It does not even so much as pretend to Doricism, except normally and nominally, by having the usual indicial marks appropriated by custom to that order. Quite as much do we regret the omission of sculpture in the metopes of the frieze, and regret it all the more because such embellishment would have been a very great novelty here, there being, as far as we are aware, not a single example in all the country of a Doric entablature so enriched—not even among those ultra-Greek porticos which modestly call themselves "after the Parthenon." The only excuse that might else have been alleged for the omission—and a most provoking one it is—is taken away by the building itself, which totally forbids the supposition that the retrenchment of such decoration, which contributes so much to the unity of ensemble in the original structure, was occasioned by any mere money-sparing considerations. If the tone of decoration was to be at all moderated, it ought to have been done more uniformly, so as to preserve keeping. Happily, it is still in time to amend the error in some degree; wherefore we would advise, that in the centre part of the composition the Doric frieze should have its metopes sculptured. Such variation there from the rest of that entablature, while it would give us a very desirable specimen of such embellishment, would be a difference conferring no more than a very allowable kind of distinction on the central portion of the façade. At any rate, we would not only recommend, but earnestly entreat Mr. Smirke to re-consider, ere it be altogether too late, his entrance porch and the door within it. How, with Sansovino before his eyes, he could have conceived the idea of such a porch is to us incomprehensible,—a small loggia of that kind, with an entablature whose architrave is supported on columns alone, being quite at variance with the mode so systematically observed for the rest of the façade. Why not fill up the front of the porch with an open arcade similar to those of the ground-floor in the original building? Besides keeping up consistency of design, it would give the expression of compactness to that projecting feature, and boldness of effect in regard to light and shade. It would produce greater richness also, as the arch would, almost as matter of course, have archivolt mouldings, as ought also to have the window on each side of the porch in that division of the front; not forgetting sculpture in the spandrels of the arches

as in the upper story, at least not for that of the porch. Hardly need we add that the doorway ought to form a corresponding arch to that in front, or that the ceiling should be likewise semicircular and coffered. If this would not materially improve the whole design, and render it more true to the spirit of Sansovino's work, we are willing to forfeit for the future our pretensions to judgment in such matters.

With regard to the species of polychromy introduced in the exterior, by employing dark polished granite for the shafts of the columns, it remains to be seen how it will bear the test of time, when the granite shall have lost its lustre, and the rest of the stone-work be tarnished and discoloured. At present, the effect—of which an outline elevation conveys no idea—is striking and vivacious enough, perhaps somewhat more so than is exactly desirable for other neighbouring façades. It is, however, a question whether colour does not require to be carried out a little more, and whether, if they were not to be sculptured, the metopes of the Doric frieze might not very properly have been filled in with polished granite also, like the panels on the Ionic frieze, the form of which last-mentioned ornaments might have been improved, they being now of more fanciful and arbitrary than tasteful design.—Our remarks are as impartial as they are free: whoever had been the architect, whether Mr. Barry or Sir Robert Smirke, we should have spoken of the "Carlton" façade just the same, except that had it been the latter, we should have heartily congratulated him on his emancipation from pseudo-Grecism, and his adoption of a style that, be it ever so *impure*, recommends itself by *Artistic* spirit.

CANDIDUS'S NOTE-BOOK. FASCICULUS LXXIV.

"I must have liberty
Withal, as large a charter as the winds,
To blow on whom I please."

I. Archæology may be likened to fire,—not on account of any brilliancy and vividity that it possesses, for to say the truth, it is apt to give out far more smoke than flame, but this it has in common with fire, that it is a good servant, but an intolerably bad master. So long as archæology is made only an auxiliary study to Architecture and Fine Art, it is serviceable enough. With that, however, it is not content, or more properly speaking, those who call themselves archæologists, are not content to have it kept within its proper bounds. They insist upon its being allowed to become quite dominant and rampant,—completely dictatorial. They themselves, knowing merely what has been done, and limiting the powers and capabilities of art just to their own little *ne plus ultra*, beyond which they have not an idea, insist upon nothing being done that cannot be shown to have been done before; thereby either insolently denying that we of the present day possess any sort of genius or talent, or still more insolently refusing us the privilege of exercising it. And what do architects themselves do? They quake and—are silent, or else fawn and flatter, thankful, perhaps, that nothing worse than mere indignities are cast upon them. Nay, some, who would be thought to have the interests of architecture chiefly at heart, seem to do all in their power to throw it into the shade, and bring forward in lieu of it the most anile rubbish imaginable,—such arrant rotten lumber that a sensible antiquarian is downright ashamed of it.

II. Unless it be restrained by that judgment and discrimination which will render it subservient to the advancement of Art, archæological study comes to be considered an end rather than a means, as which latter alone it is of any value to the architect, *quoad* architect. It may, indeed, enable him to talk or write very learnedly, and to display a deal of recondite erudition and curious research; yet, if he addicts himself to it in such manner as to make it at all his hobby, it will play him—or else cause him to play, many strange hobbyhorses. He will be always looking backwards when he should be looking forwards,—will even be afraid of getting onward a step forwarder than Precedent will permit him. That same Precedent—or rather the nonsensical and superstitious reverence affected for it, is made a positive dead weight—a millstone hung round the neck of Art. It is a chain apparently bestowed on it as a badge of honour, but made use of in reality as a halter wherewith to strangle it. Nor is it an overweening fondness for mediæval archæology alone that is

to be deprecated, that for classical antiquity, with its consequent blind and indiscriminate deference to classical authority, being equally apt to mislead—or if not exactly to mislead, to fetter, impede, and retard. Far better, in all probability, would it have been for Wilkins, had he never seen either Athens or Magna Grecia;—better at least had he dismissed them and Vitruvius entirely from his thoughts whenever he sat himself down to design, and instead of thinking of what had been done, had studiously be-thought him how to make the most of the subject in hand, had considered what new ideas it might be made to produce, and how artistic effect might best be secured for it. But, alas! artistic composition and artistic effect were almost the very last things that he, like many others, ever thought of. Had not such been the case, Downing College would have exhibited a very different piece of design from what it now actually does,—pseudo Grecism in all its pedantry and all its dulness. Neither would the same architect have vapoured so much as he did about the mere intercolumniation of the portico of the National Gallery, but would have attended much more to the general composition of that façade. The eye of an archæologist, and that of an artist—and an architect ought to be one—have very different powers of vision. The former is so myopic that it cannot discern a single inch beyond Precedent, while the other—we are speaking of the true artist—can discern with prophetic ken, *what will be Precedent* to after-ages. It is all very well to understand Precedent, but to be enslaved by it is equally absurd and despicable.

III. In a letter from a friend who is now a temporary resident at Edinburgh, I have lately received some exceedingly clever and welcome criticism on the architecture of the self-styled Modern Athens,—which designation, by-the-by, he observes is a complete misnomer as far as architecture is concerned, although Scotchmen may be sufficiently *Greek* in some respects. After expressing a rather mean opinion of the Gothic architecture of Scotland generally, which, he says, affords no studies worth the attention of an English architect, my correspondent adds, "the general rate of recent imitation of that style, in Edinburgh, is lamentably below even the local standard of antiquity. The exterior of the Assembly Hall has unquestionably many fine parts, but where is the climax which the ancient builders produced, in the interior? The Scott Monument again, the boast of all Edinburgh, obtrudes itself upon you in twenty different sizes in every print-shop—is painted on every snuff-box—graven in metal—yea! built up in confectionary; yet no architect would now get practice in England in the Gothic line, on the strength of such a master-piece—I might say such a *missy* piece as that same Scott Monument;—so defective is it in detail, and most signally so in the proportion and graduation of its lower story, which, from almost every point of view, reduces its apparent height one-third. Instead of the thousand-and-one representations of that precious Monument, I would far rather see one *satisfactory* view of Donaldson's Hospital, the finest building in Edinburgh, ancient or modern. In this structure, designed for similar objects as George Heriot's foundation, we have a very successful adoption of the combined forms known as Elizabethan, and exemplified in Burleigh. Like Heriot's Hospital, its plan is quadrangular, with a tower at each corner, flanked by four ogive-domed turrets, and a corresponding tower of bolder and loftier design marks the centre of the principal or southern front."—Thus much by way of specimen, and I hope my friend will be induced to work out his remarks fully in *extense*, and give them in some shape or other to the public, who will then for the very first time get any thing at all like intelligent criticism relative to the architecture of the northern capital, and its public buildings. One thing there is which the Edinburghers themselves might do, at least get done, which is, instead of publishing again and again *ad nauseum* the Scott Monument, to publish a collection of some of their best edifices, illustrated architecturally by plans and elevations, in some such economical form as the "Public Buildings of London," and Landon's "Edifices de Paris." Surely Playfair, Hamilton, Rhind, and others who have shown talent in some of the recent structures, would gladly promote an undertaking of the kind,—in which sections and interiors ought not to be quite forgotten—certainly not such as the hall and principal apartment in the new Commercial Bank, which last-mentioned apartment appears from description to be quite unique as a public "business-room," it having a Corinthian colonnade on each side, and being moreover enriched with decorative painting, marbling, and gilding, most probably by Mr. Hay—although that is merely my own conjecture. The hexastyle Corinthian portico of the exterior, with its pediment filled in with statues in full relief, might pass for classical, were not such character sadly marred by the two ranges of windows within; whereas had there been none below, but only the doorway there, the upper ones might have been excused.